INFANT FEEDING

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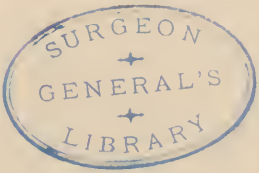
A Handbook for the Practitioner

JULIUS H. HESS, M.D.

Professor and Head of the Department of Pediatrics, University of Illinois, College of Medicine; Chief of Pediatric Staff, Cook County Hospital

1923



AMERICAN MEDICAL ASSOCIATION
535 North Dearborn Street Chicago, Illinois

PREFACE

This series of articles, somewhat elaborated for book form, appeared in the *Journal of the American Medical Association* from January to May, 1923. The interest they aroused and numerous requests for publication in book form, have prompted the issuing of this volume.

CONTENTS

Fig. 1.—Proper method of holding baby during nursing. The nurse is seated on a low nursing chair with her right foot elevated on a low stool.

CHAPTER I

BREAST MILK FEEDING

From every standpoint, the ideal mother is one who can nurse her own baby, and thereby furnish it with sufficient milk to meet its needs for normal growth and development. The mother who is not anxious to nurse her infant is a great exception. In fact, most women are greatly disappointed at being unable to meet the full requirements of their baby.

The mother can easily be impressed with the fact that breast milk is the ideal food for a baby. It is always fresh; with a simple technic it remains clean, and it is always available. From the standpoint of economy, it is by far less expensive than other foods. It is the best prophylactic against the communicable diseases and the commoner infections in infancy, and as a curative measure in the presence of nutritional disturbances and infections it has no peer.

Even more important is the fact that the infant is assured a mother's careful observation, owing to its frequent and intimate contact with her. She soon learns to recognize the earliest manifestations of its illnesses. It must be recognized as a fact that most mothers are capable of nursing their infants.

It cannot be denied that there are mothers whose mental and physical condition makes breast feeding inadvisable, but fortunately they are greatly in the minority. Breasts with an insufficiency of glandular tissue to meet the full needs of the infant, even during the first months of lactation, are encountered more frequently. Far less commonly do we find breasts so poorly developed that all lactation is to be disregarded.

McClanahan,[1] summarizing the opinion of a group of pediatricians whom he interrogated for opinions

1. McClanahan, H. M.: Arch. Pediat. 35:653 (Nov.) 1918.

as to the relative morbidity among breast and bottle fed infants, concluded:

> Breast-fed infants are less susceptible to infection, with possibly two exceptions—influenza and tuberculosis. They resist infection to better advantage and with less after-effect from the disease. Breast-fed infants have less morbidity than properly fed bottle infants, and the advantages are still greater as compared with infants who have been improperly fed.

Studies made in many different countries have demonstrated that the death rate among the artificially fed is at all times higher than among the breast fed; that when breast feeding is the custom, the mortality rate is low in spite of other unfavorable factors; and that when breast feeding is increased in a community, the infant mortality rate is lowered.

In studies made in overcrowded and poverty-stricken districts of London, New York, Chicago and other large cities, the fact is very clearly brought out that where by race or custom it is the practice to feed infants at the breast, the infant mortality rate is lower, even though the environment is highly insanitary.

In our complicated modern society, there must be widespread emphasis among all classes, not only on the importance of breast feeding but also on the ways and means of making it successful. There are many false opinions to be overcome, such as the statement frequently made that the modern woman has lost the ability to suckle her young, and the feeling created, as a result of the emphasis on the importance of pure milk and pasteurization in infant feeding, that this is at least as good as breast feeding and often better.

The reports of Sedgwick[2] of the findings of the Breast Feeding Investigation Bureau of the University of Minnesota confirm the ideas which many physicians

2. Sedgwick, J. P.: Preliminary Report of Study of Breast Feeding in Minneapolis, Am. J. Dis. Child. **21**: 455 (May) 1921.

have held, that in greater part the inability of the mother to nurse her infant is due to improper instruction and insufficient encouragement on the part of the attending obstetrician and those responsible for her nursing care.

Only too frequently when the question is asked, "Why did you wean your child?" the answer is, "Because the doctor advised me to do so." Knowing how commonly this is true, there is certainly room for missionary work in order that breast feeding may receive further encouragement.

The University of Minnesota breast feeding bureau supervised the care of 2,847 babies during the year 1919. Of these, 96 per cent. were at the breast at the end of their second month, and of 2,022 still under observation at the end on nine months, 72 per cent. were at the breast receiving part or all of their food in this way.

In Boston, the Baby Hygiene Association has had such success, that of 6,000 infants under its supervision only 196 babies less than 6 months old were entirely artificially fed. The statistics of the Starr Center in Philadelphia are equally notable. In 1912-1913, only 48 per cent. of the babies under its care were breast fed. After six years of propaganda for breast feeding, of ninety-two infants whose mothers had been cared for by the prenatal department, ninety were entirely breast-fed at 1 month of age, one was partially breast-fed, and only one was bottle fed.

STIMULATION OF THE BREASTS

The demand which is made on the breast is by far the most important factor in the maintenance of the breast milk supply. Repeated, regular and complete evacuation of the breasts by a vigorous baby is, of course, the natural and best method. When this natural stimulus is not obtained, or when the demand on the breast is insufficient for any reason, the supply of breast milk decreases gradually until the supply is insufficient to meet the infant's needs. In these cases, artificial aid is necessary.

HAND EXPRESSION

Expression by hand is the best method for stimulating the breasts to secrete, when an infant is not available for this purpose. Wetnurses find it of the greatest advantage to practice expression at regular four hour periods, and when the breast is practically drained to place the wetnurse's infant at the breasts to empty them completely, both breasts being emptied at each period. The following methods for breast expression may well be followed:

The hands and nails should be scrubbed with soap, warm water and a nail brush, for at least one full minute. The nipple is washed with fresh absorbent cotton and boiled water or a boric solution. The hands are dried thoroughly on a clean towel and kept dry. A sterilized graduated glass tumbler or large-mouth bottle should be at hand to receive the milk.

1. The breast is grasped gently, but firmly, between the thumb placed in front, and the remainder of the fingers on the under surface of the breast. The thumb in front and the first finger beneath should rest just outside the pigmented area of the breast.

2. With the thumb, a downward pressing motion is made on the front against the fingers on the back of the breast, and the thumb in front and fingers behind are carried downward to the base of the nipple.

3. This second act should end with a slight forward pull with gentle pressure at the back of the nipple, which causes the milk to flow out.

The combination of these three movements may be described as "back, down, out."

It is not necessary to touch the nipple.

This act can be repeated from thirty to sixty times a minute after some practice.

It is advisable to empty both breasts at each expression

The milk should be covered at once by a sterile cloth held in place by a rubber band and kept on ice until used.

Hoobler[3] reports that in the city of Detroit during two succeeding years, 67,000 ounces and 60,000 ounces,

3. Hoobler, B. R.: Tr. Am. Ped. Soc. 32: 290, 1920.

Fig. 2.—Direct expression of milk, first stage.

Fig. 3.—Direct expression of milk, last stage.

respectively, of milk was expressed from the breasts of women in different institutions and from private sources, and distributed throughout the city. Continued stimulation of the breasts by expression of the milk resulted in increasing quantities of milk.

Understimulation of the breasts results in a deficient milk supply.

CHAPTER II

MATERNAL NURSING

The Diet of the Mother.—The first principle of feeding a nursing mother should be to provide her with an abundance of simple but nourishing food. It should always be palatable and to the mother's liking. During the first days following labor and while she is still in bed, she should be on a more or less light diet, but one that is varied so that her appetite may be stimulated; she may thereby be encouraged to take sufficient food to meet the needs of the infant and herself. Four meals in twenty-four hours are usually all that she will take with comfort, while in bed.

When the mother is up and about, and has resumed her ordinary duties, she may be allowed to eat such foods as she was accustomed to before the advent of pregnancy and motherhood. It is a fallacy to forbid vegetables and fruits on general principles. As a rule, food that the patient can digest without inconvenience is a safe food, so far as the nursing is concerned. Occasionally an infant is seen who reacts to mother's milk by the development of colic when certain of the aromatic vegetables, such as turnips, cauliflower and onions, are a part of the mother's diet. Or, again, the same foods, or such additions to the mother's diet as coffee or salads, may interfere with her digestion and thereby change the quantity and not infrequently also the quality of her milk, all of which may react upon the child. Exceptionally an infant is seen that has become sensitized to one of the animal or vegetable proteins. These cases will be more fully discussed under "Idiosyncrasy to Mother's Milk." Restrictions in the mother's diet are, however, more especially indicated when she is feeding a premature or

sick infant, because such infants are more readily affected by qualitative changes in the breast milk. More commonly, the error in the mother's diet lies in the nature of underfeeding and overfeeding. A greatly restricted diet in a robust young mother who has always eaten to her own satisfaction of a generous variety of foods is one of the surest means of curtailing the quantity and lowering the quality of her milk supply. On the other hand, overfeeding leads to revulsion to food, and sooner or later indigestion results. When the mother is convinced that any article of food disagrees with her, even though there may be doubt about it, the food should be discontinued. In a general way, milk, eggs, meat, fish, poultry, cereals, fresh vegetables and fruits should constitute the basis for selection. The acid fruits, salads and aromatic vegetables may be tried, to be discarded if they seem to distress the infant. Eggnogs, cereal gruels with milk, cocoa with milk, malted milk, and similar drinks can be given with the meals; or, when the mother desires, she may take them between meals. The day's diet should include 1 quart of milk in some form, and at least 1 quart of water. Tea and coffee in moderate amounts may be permitted.

Number of Meals.—Most mothers are better satisfied when eating only four times daily, the fourth meal being supplied at bedtime. The latter should consist of a dish of cereal and milk, or some other simple and easily digested food.

Air and Exercise.—From two to four hours daily should be spent in the open air, weather permitting. During this outdoor period, she should take moderate exercise, but never to the point of fatigue. It is well to divide the time of recreation into a morning and an afternoon period.

Sleep.—At least eight hours out of every twenty-four should be given to sleep. If her nights are disturbed,

she should have the benefit of an hour or two rest period during midday. In case the infant has been accustomed to a feeding during the night, this should be withdrawn as soon as possible so that there will be only one nursing period between 6 p. m. and 6 a. m. This is most easily accomplished when the infant sleeps in a room separated from the mother and is under another's care during the night. Under all circumstances, the infant must sleep in its own crib.

To Avoid Constipation.—One free evacuation daily should be insisted on. As the excessive use of cathartics may result in diarrhea in the baby, efforts should be made to regulate the bowel function through food and exercise. A glass of cold water on arising in the morning, combined with a diet containing coarse cereals, sufficient vegetables and fruits, is usually all that is necessary. If this regimen does not have the desired effect, abdominal massage and local measures, such as an oil enema or a suppository, may prove effective. When these measures do not prove effective, it may be necessary to administer mild laxatives, such as liquid petrolatum, magma magnesiae or cascara sagrada. If no evacuation of the bowels has taken place during the previous twenty-four hours, an enema should be administered at bedtime.

Care of the Breasts.—During the latter months of pregnancy, a small amount of clear fluid is secreted by the breasts. Toward the end of pregnancy, and for the first few days after labor, colostrum is secreted. By the third or fourth day the character of the secretion is changed so that it resembles the later milk in both its physical and its chemical properties. The specific factor or factors which stimulate milk secretion are as yet unknown, but it is not unlikely that it may be in the nature of an enzyme. Two important results follow continued stimulation of the breasts by the infant: (1)

Fig. 4.—Breast tray and its contents: tray, boric solution, liquid petrolatum, gauze in jar, cotton in jar, glass, applicators in jar.

contraction and involution of the uterus, and (2) increased secretion of breast milk. In the average breast, feeble stimulation results in a minimal milk supply, while stimulation by a strong infant or regular expression will be followed by a supply varying directly with the demand made on the breasts.

In the presence of small nipples, slight traction night and morning during the last months of pregnancy has a beneficial effect in lengthening the nipple.

A well established routine should be instituted for the care of the breasts during the period of lactation. To facilitate this, a readily accessible *tray with the necessary utensils* should be provided. This should contain a glass-stoppered bottle with a saturated solution of boric acid, a jar of cotton pledgets on toothpicks, to be used as applicators for the boric acid, and a graduated glass or beaker. The nipples should be thoroughly washed before and after nursing with a saturated solution of boric acid poured fresh from the bottle for each cleansing, and the surplus thrown away. The boric acid should be applied with the cotton pledgets. The fingers should not come in contact with the nipples, if the child is to nurse directly at the breast. If the nipples are tender, they should be anointed with a sterile mixture of 5 per cent. tincture of benzoin in liquid petrolatum.

In some cases, when the milk first comes in, the breasts may become engorged and painful. Usually this rights itself without difficulty as soon as the relation between the supply and demand is established. During this period of adjustment, besides limiting the fluids taken, the discomfort from engorgement may be relieved by elevating the breasts and keeping them partially under pressure by the use of a supporting breast binder. If a binder is used in time and the mother takes little fluid in her diet for a few days, it is rarely necessary to empty the breast by expression or

with a breast pump. If left alone, mild cases of caked breast will disappear without treatment. Unnecessary handling of the breasts should be avoided. Besides limiting the fluid intake, laxatives are indicated. The vegetable cathartics are less likely to pass into the milk than are the salines. An icebag applied externally to a thin binder often will be of assistance. If the cold application produces discomfort, as occasionally it does, hot boric dressings protected by oiled silk may be used. These should be repeated at hourly intervals. The infant should be put to the breast regularly.

Fissures.—These offer serious difficulties to nursing because of pain and the danger of mastitis. Nursing through a nipple shield should be tried in order to minimize the danger of infection. When the infant cannot or will not use the shield, expression should be practiced. Failure to empty the breasts by these methods may make it necessary to risk the danger of infecting the breasts by allowing the infant to nurse directly from the breasts. When a nipple shield is used, it is imperative that it be cleaned thoroughly after nursing and reboiled before using. Among the best local applications are silver nitrate solution, 5 per cent., followed by an ointment, such as balsam of Peru, 1 part, and castor oil, 30 parts; or silver nitrate, 1 part, balsam of Peru, 2 parts, and sufficient petrolatum to make 30 parts.

Mastitis.—This is of frequent occurrence, even during the week following delivery, manifesting itself by headache and circumscribed pains in the mammary gland. The disease is usually confined to one of the lower quadrants. Tenderness, swelling, surface reddening and hard nodular points follow. The course of these mastitides, most of them parenchymatous, is favorable.

Much more serious are those cases which occur later, usually about three weeks after delivery. They

begin more violently, with high fever, headache, vomiting, reddening of the skin and tumor formation which is painful to pressure. The pain is exhibited both at the seat of the trouble and in the axilla. With improper treatment, abscess formation quickly occurs and is often followed by repetitional relapses. In these cases we have often to deal with an interstitial mastitis.

Great care should be taken in differentiating between a simple engorgement (caked breast) and mastitis. As in the former, there is every indication for keeping the child at the breasts, in order that they may be emptied at regular intervals. Further indications for treatment in caked breast are met by a dry diet and purgation. When a diagnosis of mastitis is established, the infant should be removed from the breast and a tight binder applied. Two large icebags should be applied to each breast, kept half full so that they may not be too heavy. The binder should be thin, so that the icebags are not separated from the skin by enough cloth to prevent the cold from reaching the gland. The skin must feel cold to the touch; otherwise, no good will be derived from the ice. A saline cathartic may be given, and the liquids in the diet are restricted. The icebags may be removed one at a time after the patient has had a normal temperature for twelve hours. The infant is put back to the breast twenty-four hours after the temperature becomes normal.

If an abscess develops, the pus should be evacuated through radiating incisions. Even in the presence of abscess formations it is only exceptionally necessary to wean the infant. Usually by the end of the first week, even though the wound is still open and draining, the infant can be returned to the breast, after the first milk at each nursing is expressed and discarded. This will be found to have a favorable influence on healing. In most cases the breast function is soon reestablished.

CHAPTER III

CONDITIONS TEMPORARILY AFFECTING THE QUANTITY AND QUALITY OF BREAST MILK

In many women the return of the menstrual period is associated with changes in the breast milk. This is especially true of the first menstrual period. In some instances they may occur with each menstruation. They may be both quantitative and qualitative. In cases of simple reduction in the food, the infant will frequently show signs of hunger. At other times, when there are also qualitative changes, colic and indigestion, the latter associated with frequent stools, occurs.

Menstruation is never an indication for weaning, and only rarely should any of the feedings be discontinued at these times, even though they cause minor disturbances in the infant. Disturbances are most frequently seen either before or during the first menstrual period.

The mental condition of the mother may have a direct influence on the milk secretion. These changes are, however, usually only temporary. When the infant is distressed at these times, it may be wise temporarily to remove it from the breast for one or two days, until the mother has recovered from the underlying cause, such as grief, shock, fright or anxiety. Expression should be practiced in the interim.

Drugs.—Alkaloids of opium, hyoscyamus, belladonna and similar drugs not infrequently pass into the milk and should therefore never be administered in large quantities to the nursing mother. Belladonna may cause a decrease in milk secretion and should be administered with caution during the period of lactation.

Mercury, iodids and the newer salts of arsenic are also secreted in the milk and may be used to advantage when a syphilitic mother is nursing her infant.

Contraindications to Nursing.—Tuberculosis, when progressive or open, is always a contraindication to nursing, because of the danger to the infant and the strain on the mother. With proper precautions, and when the breast is not diseased and human milk is not obtainable from other sources, it may be well to tide a weak infant over its first weeks by expressing the milk from the mother's breasts. It must be boiled before it is used.

Syphilis of the mother, except in freedom from infection on the part of the infant, is not a contraindication. Lack of the symptoms on the part of the mother in congenital syphilis is a very common occurrence; a Wassermann reaction on the mother's blood will usually clear up any doubt.

Any grave constitutional disease in which there is an extraordinary drain on the resources of the body, such as diabetes, heart disease with disturbed compensation, nephritis, exophthalmic goiter, malignant neoplasms, epilepsy and psychoses are contraindications to nursing.

Acute diseases should only in exceptional cases be considered as contraindications to nursing. Only conditions in which there is danger of overburdening the mother and infecting the infant should lead to its removal from the breast.

In acute infections in the mother, such as pneumonia, and the acute contagious diseases, such as scarlet fever, after considering the condition of the mother, one must weigh the danger from exposure to infection of the infant, as against the quality of the artificial food and environment in the individual case.

In the milder contagious diseases, such as measles or mumps, it is true that young breast-fed infants are rarely infected. Pertussis is an exception and has a high mortality in the new-born and young infants, and the infant should under all circumstances be protected from exposure. In the presence of diphtheria, the infant can be immunized with safety.

Pregnancy.—Only under exceptional circumstances, such as congenital weakness or illness on the part of the infant, should a mother be called on to prolong lactation after she becomes aware of her condition. First, she should not be called on to undergo the strain of nourishing her infant, the fetus and herself. Secondly, conception rarely occurs during the first months of lactation, the infant thereby having had the benefit of a good start on the breast, and bottle feeding can usually be instituted without great danger.

EXAMINATION OF HUMAN MILK

No baby should be deprived of its mother's milk because of the results obtained on chemical analysis. The baby, and not the laboratory, offers the practical test for judging the quality of breast milk. It is well known that the composition of milk, more especially in its fat and to a lesser degree in its protein and sugar content, varies greatly in the same individual, not only from day to day, but also at different periods of the same nursing. An analysis, therefore, to be of value, should be made from a specimen obtained from several expressions during the twenty-four hours, and each specimen should consist of the milk of an entire expression or the middle portion. The latter can be accomplished by allowing the infant to nurse for two or three minutes before the sample is expressed. A safer method would be to collect samples at all of the regular nursing periods. It is also essential for any

conclusion that the total amount of the milk obtained in twenty-four hours be known through weighing the baby before and after each feeding. It is also to be remembered that the quality of the milk cannot be gaged by simple chemical analysis, because of the impossibility of estimating some of its most vital contents. Repeated examination of the milk from different wetnurses secreting about the same average quantities has shown marked variations in the chemical composition, notwithstanding which fact the infants under observation made equally good progress on the different milks. Again, normal chemical averages may be found in milk lacking essentials for the proper growth of the infant.

TABLE 1.—*Composition of Mature Breast Milk*

Reaction	Amphoteric or alkaline
Specific gravity	From 1.010 to 1.040
Fat	3.0 to 4.0 per cent.
Sugar	6.0 to 7.0 per cent.
Protein	1.5 to 2.0 per cent.
Salts	0.2 per cent.
Water	86.0 to 88.0 per cent.

The average composition of mature breast milk approximates the figures given in Table 1.

On the addition of rennin it clots in fine curds. Oppenheimer [4] says:

In general, variations in quality determined by analysis fall into three types:

1. All elements too high: This type is most frequently found in women who do too little and eat too much and too rich food.

2. Fat and sugar low, proteins high: This type is usually found in women of the poorer classes who are overworked and underfed.

4. Oppenheimer, E.: Pub. 83, Breast Feeding Children's Bureau, Washington, D. C.

3. Fat and sugar very low, proteins very high: This type is usually found in the highly strung, overeducated and highly civilized women of the larger cities, but may be found in neurotic women of any class or community.

In recent years variations in the nutritional properties of human milk have been shown to be due to its vitamin content. The vitamins of human milk are supplied from the food taken by the mother; if they are not present in sufficient quantities in her food, the milk suffers. The effect of an insufficient amount or absence of these substances is exhibited in the child. Scurvy, for example, in the breast fed has been shown to develop because of the deficiency of the antiscorbutic factor in the mother's food. The development of rickets in the breast fed has also been shown to be due to a deficiency in the mother's diet, reflected in the quality of her milk.

CHAPER IV

THE NURSING PROPER

Regularity in Nursing.—The breast that is emptied at definite intervals invariably functions better than does one which is not, as regards not only the quantity, but also the quality of the milk. Thus, regular habits in breast feeding are as essential to milk production as to its digestion and assimilation. *The baby should be wakened to be fed.*

The average mother will supply the needs of the individual meal with one breast, and the breasts should be alternated in successive feedings. Thorough emptying of the breast should be encouraged under all circumstances, as this is our best method for increasing the milk supply, and the baby is the only means at hand by which this can be accomplished. This should be encouraged in every instance. It is most readily thwarted by allowing a lazy baby partially to empty both breasts, as this will soon lead to a diminished milk secretion.

Sometimes, however, it is advisable to give *both breasts* at each feeding, e. g., (1) during the first few days to stimulate secretion, and a little later to relieve the congested breasts; (2) to weak babies when there is an abundance of milk and they are not strong enough to get the last milk, which comes harder; this is to be followed by expression; (3) to overfed babies, when it is desirable to give them only the first and weakest milk and to lessen the yield of milk from the breast; (4) as the milk supplied by one breast fails to meet the needs of the infant. The first breast should be thoroughly emptied before the baby is allowed to take the second breast and the next nursing started on the second breast given in the last feeding.

Number of Feedings in Twenty-four Hours.—Four-hour intervals should be observed at the outset, with either five or six feedings in twenty-four hours, according to the individual needs of the child. Night nursing can often be discontinued by the second month, and babies properly fed will go from 10 p. m. to 6 a. m. without anything but perhaps a drink of water.

A three-hour nursing period is more especially indicated when the mother's breasts are small and poorly developed, as the more frequent stimulation will result in a larger twenty-four hour quantity. The same is true of a small and weak infant who finds it difficult to remain at the breast through the entire nursing period.

Length of Nursing.—As a rule, a robust baby takes three fourths of the milk obtained from a good breast in the first five minutes of a twenty-minute nursing. From fifteen to twenty minutes should be the limit for the nursing period.

The quantity received at individual nursings will vary greatly throughout the day. The early morning nursings will often yield twice the amount of the later nursings. Therefore it is necessary to ascertain the twenty-four hour quantity in order to estimate the total value of milk received.

When one breast does not meet the infant's demands, both breasts should be given at each feeding, the normal nursing time of fifteen or twenty minutes being divided between the two breasts, either equally or by alternating a long and short feeding period of fifteen and five minutes, so that each breast will receive a long nursing period at alternate feedings. Weak and lazy babies may require awakening during the nursing period to keep them at work. Very weak babies may require a longer period, with short intervals in which they rest.

The Daily Total of Milk Required.—Most young infants will satisfy their requirements for growth and development when receiving an average of 2½ ounces (75 c.c.) of human milk for each pound (0.45 kg.) of body weight in twenty-four hours. Roughly, this may be stated as one sixth of the body weight in milk daily (50 calories for each pound). Older infants will usually thrive on 2 ounces (60 c.c.), or 42 calories of breast milk for each pound, or one eighth of their weight.

While infants of the same weight and age under the same conditions will require virtually the same amounts to provide for growth and development, on the whole the fat baby will require less for each pound than the thin one.

Heubner thus expresses the needs of breast-fed infants in terms of energy quotient:

> During the first few months, an infant requires 100 calories per kilogram daily of breast milk; after the sixth month the energy quotient gradually comes down to 80 or 85 at the end of the first year. An energy quotient of 70 is the minimum amount that an infant can take without losing weight.

Human milk can be estimated at 21 calories for each ounce, or about 70 calories for each hundred cubic centimeters of milk. With these figures in mind, it is easy to determine whether a breast-fed infant gets the right amount of food. It may well be emphasized that the infant who is making a normal gain should offer little cause for anxiety as to the exact quantity it may be receiving from day to day.

Water Requirements.—When the infant is receiving one sixth of its body weight in milk during the day, little if any additional water is required. When the breast milk does not meet this requirement, additional water and other food must be administered to meet the required one sixth of the body weight in fluids. Dur-

ing the first days of life, when the breast milk supply is insufficient, total fluids should be administered to meet the needs mentioned above. From 1 to 3 ounces (30 to 90 c.c.) of a 2 to 5 per cent. solution of sucrose or lactose which has been boiled may be given to the infant at four hour intervals until the milk appears.

Before the water is given, the infant should be placed at the breast at each feeding. Even when milk is plentiful, the administration of water two or three times daily from a nursing bottle accustoms the infant to taking the food in this way. An infant so trained will meet emergencies of weaning more readily than one unaccustomed to bottle feeding.

Feeding During the First Days.—During the first day of life, food may be withheld for twelve hours, the infant being kept in a warm crib. It usually soon falls asleep, and as a rule it should be awakened only to change diapers. As a rule, the child does not evidence its initial sensation of hunger by crying until after its first half day of life; and even then, in many cases, it is difficult to obtain the cooperation of the infant in administering its food. During the second twelve hours the infant may be put to the breast two or three times in order to stimulate secretion and to teach it to nurse. During the second twenty-four hours the baby should be put to the breast at regular four-hour intervals. The sixth feeding may be omitted. By the third or fourth day the infant will usually receive most of its required food from the breast. If a night feeding is to be instituted, it is well to waken the baby at the regular hour in order to cultivate regular habits, which are so essential to the mother's welfare. The infant should at all times be *taught to take food by the clock.* This means that it should not be nursed before the accustomed hour nor should its feedings be delayed beyond its regular

time unless an emergency arises. When the infant either cannot take or does not receive sufficient food on the four-hour nursing period, with five or six nursings in the day, it should be put on a three-hour period, with seven feedings in twenty-four hours. The average infant can be trained by the second month to wait regularly for its food; and if the milk is of proper quality and of sufficient quantity it will sleep quietly for most of the interval between nursings.

Initial Weight Loss.—An initial weight loss is physiologic, and in the main is due to the loss of water through the skin, lungs and kidneys, and the meconium, by way of the intestinal tract. Necessarily, the weight loss is directly influenced by the amount of fluids ingested. To a certain extent the weight decrease depends on the size of the child, the weight loss, on the whole, being greater in a large infant than in a small one. The decrease usually continues for from two to five days after birth. The average weight loss will range between 8 and 10 per cent. of the body weight. Losses above the latter figure should always lead to careful study of the milk supply and water intake, and usually indicate a necessity for complemental feedings of carbohydrate solutions alone, if the breasts seem of good quality, or of milk mixtures. Schick [5] has found that he can prevent most of this initial weight loss by the feeding of sugar solutions during these first days, giving as high as 1 ounce (30 gm.) of sucrose during the twenty-four hours. Herman reduced initial weight losses one half in a study of 200 new-born infants by feeding 1½ ounces of a 10 per cent. solution of lactose every 3 hours. More recently it has been found practical to use a 5 or 10 per cent. solution of corn syrup as comple-

5. Schick: Ztschr. f. Kinderh. **27**: 57, 1920.

mental feeding, the total day's feeding, including the breast milk, averaging one sixth of the infant's body weight.

The Total Nursing Period.—Some mothers will be able to carry on the nursing for only two or three months; others as long as nine months. In outpatient as well as in private practice it is exceptional to find a breast milk supply which is sufficient for the infant after the ninth month. It is usually wise to allow one bottle feeding daily by the end of the third or fourth month in order to relieve the mother and at the same time train the baby in bottle feeding.

Protracted Nursing.—Weaning may be delayed when the infant is passing through the hot months of summer and when the quality of the cow's milk supply is uncertain. It may also be delayed when the infant is convalescing from a recent illness or in the presence of epidemics of acute infectious diseases.

Signs of Successful Nursing.—The normal full-term infant shows a gain of not less than 4 ounces (120 gm.) weekly. This is the minimum weekly gain that may safely be allowed. When a nursing baby remains stationary in weight or makes a gain of only 2 or 3 ounces (60 or 90 gm.) a week, it means that something is wrong, and the defect will usually, but not invariably, be found in the milk supply. When the baby is nursed at proper intervals and the supply of milk is ample and of good quality, it is satisfied at the completion of the nursing. Under 3 months of age it falls asleep after ten or twenty minutes at the breast. When the nursing period again approaches, it becomes restless and unhappy, crying lustily if the nursing is delayed. When the breast is offered, it takes it greedily. The weekly gain in weight under such conditions is usually from 4 to 8 ounces (120 to 240 gm.). At

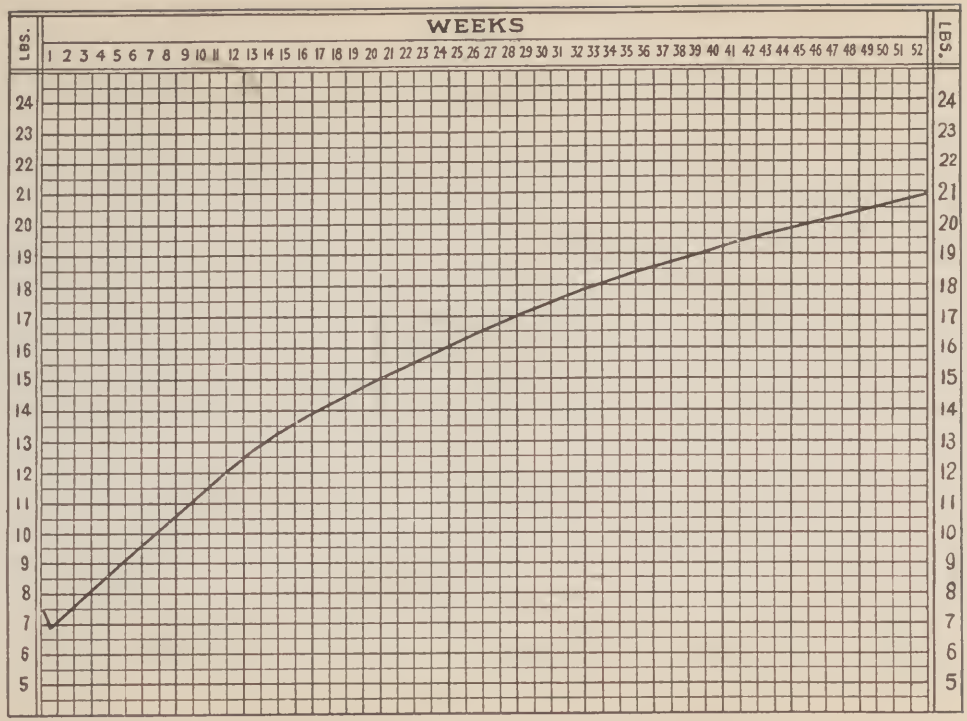


Fig. 5.—Average weight curve for normal infants during the first year.

the fifth month the baby will have doubled, and at the twelfth month trebled its birth weight. The average gain for each week during the first year usually approximates 5 ounces.

Stools.—The feces of breast-fed babies are strikingly uniform and are like no other bowel movement in infancy. Normally there are two or three a day, sometimes only one, or, again, more than three. They are soft or mushy, homogeneous, of an egg-yellow or gold color, and have a slightly sour, not at all unpleasant odor. They are never formed and always cling to the diaper. The nature of the bowel movement, and its uniformity, is due to the "physiologic fecal flora" which is brought about by the ingestion of breast milk into the germ-laden intestinal tract. The dominating organisms have a fermentative rather than a putrefactive action on the food. The gases normally formed are carbon dioxid and hydrogen, and these are almost odorless. The acidity of the movement, its softness, and the mechanical action of the gases present, all insure active peristalsis and ready emptying of the bowels, so that true constipation is an exceptional condition in a breast-fed baby, and, if present, nearly always suggests too little food, or abdominal and intestinal muscles too little developed and too weak to force the stool past the anal sphincter. More often the stool is simply retained above the anus, owing to lack of peristalsis sufficient to overcome the anal sphincter. The latter condition is commonly interpreted as constipation by the laity.

The feces of the breast-fed baby are frequently not wholly normal; they quite commonly, especially during the first few months, contain small, soft, white or yellowish fat curds, an excess of mucus, and are often greenish, and may be more frequent than normal. *Such a condition is perfectly consistent with a normal growth and well-being of the baby, and should never*

in itself be a cause of worry, or an indication for a change of food. This is a very important point that is commonly neglected. The condition of the bowel movements is only one factor, and in the breast-fed a minor one, in determining a baby's nutrition.

Signs of Unsuccessful Nursing.—The most significant symptoms are a stationary or insufficient gain in weight or losses in weight, fretfulness on the part of the infant while nursing, a tendency to remain for too long a time at the breast, and crying when it is removed from the breast. Small stools composed largely of mucus are usually an indication of insufficient food, especially when only one or two are passed daily. While every effort should be directed toward maintaining the breast-milk supply, it is of equal importance to interpret the symptoms of underfeeding as indications for complemental or supplemental feedings.

Except in the presence of extreme emergency, breast feedings should not be discontinued suddenly. It is always wise to continue as many feedings at the breast as may be warranted by the circumstances in the individual case.

CHAPTER V

MIXED FEEDING AND WEANING

The main indications for mixed feeding are: 1. To furnish sufficient food to meet the infant's needs when the mother's supply becomes inadequate. This is best accomplished by *complemental feeding* by the administration of cow's milk mixture after a limited period on the breasts. 2. To relieve the mother of one or more breast feedings to provide for her recreation. 3. To teach the infant bottle feeding in the preparation for emergencies. The two latter conditions will necessitate replacing breast by bottle meals. These are known as *substitute feedings*. Whichever of these two methods of extra feeding is adopted, the all important question to be answered for the mother is what foods and how much of them shall be given to replace the breast milk. It has been stated that average infants will require amounts approximating 2½ ounces (75 c.c.) for each pound of body weight, of breast milk in twenty-four hours.

It is necessary to weigh the infant before and after nursings for one or more days to obtain a fair idea of the amount of cow's milk mixture that it will be necessary to administer in cases of underfeeding at the breast. Example: Given a normal infant weighing 10 pounds (4.5 kg.), the food value of 25 ounces (700 c.c.) of breast milk should be approximated (one sixth of the body weight). Comparative determinations of human and cow's milk show, on an average, fat, 3.5; protein, 1.5; carbohydrate, from 6 to 7.5 in the former, and fat, 4.0; protein, 3.5; carbohydrate, 4.5, in cow's milk.

Clinical experience has taught us that most infants will thrive on artificial mixtures approximating the

food values contained in breast milk. Roughly, 1½ ounces (45 c.c.) of cow's milk to which ⅒ ounce (3 gm.) of sugar (cane or milk) and 1 ounce (30 c.c.) of water has been added, will meet the requirements for each pound of body weight (0.54 kg.).

It is a safe and rational plan to think of the infant's needs in grams of fat, protein and carbohydrate for each pound of body weight. The breast-fed infant receiving 2½ ounces per pound receives, fat, 2.6; protein, 1.1, and carbohydrate, 5.0 gm., daily for each pound of body weight. These values are approximated by 1½ ounces of cow's milk with ⅒ ounce of sugar and 1 ounce of water added (fat, 1.8; protein, 1.57; carbohydrate, 5.0). Example: A 10-pound infant receiving 15 ounces of breast milk is receiving 2½ ounces for each 6 pounds of his body weight, and will require in addition the equivalent of 2½ ounces of breast milk for each of 4 pounds of body weight, which can be supplied by 6 ounces or one and one-half times four of cow's milk, and ⅘⅒ ounce of sugar.[6] To meet his water requirements, the mixture should be made 10 ounces, adding 4 ounces of boiled or cereal water.[7]

The cow's milk mixture can be divided into equal parts to be given from the bottle as complementary feeding following the breast nursings.

The exception to these food requirements is the thin infant whose substitute feedings must approximate the requirements of his full weight for his age. It is to be remembered that small *fat* infants require less total food than large infants of the same age. (Further details for artificial feeding will follow.)

Food Other Than Milk Mixtures.—Most infants may be given small quantities of orange juice during

6. Two level tablespoonfuls of cane sugar equal 1 ounce; 3 level tablespoonfuls of milk sugar equal 1 ounce.

7. One kilogram equals 2⅕ pounds; 30 c.c. (or 30 gm.) equals 1 ounce.

the third month of life, even though they are exclusively breast fed. During the fourth month, small quantities of well-cooked cereals can be started, and during the early part of the second half year a vegetable and meat broth may be started to advantage. These additions may be made to the diet even when the breast milk supply is sufficient to meet the caloric requirements. Besides rounding out their diet, they prepare the infant to meet the emergencies of a diminishing breast-milk supply.

WEANING

Weaning should always be done gradually, when possible, for the sake of both mother and child. The first months in the life and development of a child are the most critical period. Weaning at this time is a serious matter. A well baby after he is 6 months old can, as a rule, be successfully weaned when necessary, if it is properly done. However, at least part breast feeding should be continued throughout the next three months, or even longer, if possible, depending on the infant's health, the season and the other circumstances. When a mother cannot give her infant at least two satisfactory breast feedings daily, it is advisable to wean the child.

Sometimes a baby cannot take cow's milk; in such a case milk from a goat may be tried. This has been of great value in some cases of exudative diathesis.

As a rule, the trouble in weaning is not because the infant cannot digest cow's milk, but because the change is made too suddenly or the food given at first is not properly adapted to the infant.

In cases of sudden weaning, the food must be weaker in the beginning than for an artificially fed child of the same age. If weaned at 6 months, the infant should be put on a mixture for a child of 2 or 3 months,

and the same rule applies for older infants. When the infant becomes accustomed to cow's milk, the strength can be gradually increased.

By gradually changing this way from breast feeding to bottle feeding, weaning can usually be completed in two weeks without upsetting the baby. It is very seldom necessary to wean in a shorter time than this and there is every reason to wean gradually so as to prevent any disturbance. Rarely should breast feeding be continued past the first year.

The fear of the laity of the "second summer" is well founded when dirty milk and other improper foods are fed promiscuously; but with clean, certified and sterilized milk and properly prepared soft foods the dangers of the summer heat are minimized. It should be the rule to underfeed rather than overfeed in hot weather; during the extreme hot spells the diet may well be reduced by one third or even one half.

CHAPTER VI

THE PHYSICIAN

It is necessary that the medical adviser, in order that maximum breast feeding may be maintained, shall impress on his patient that the instances in which the mother's milk will not agree with her own baby are very rare; that the first few days and weeks form the most critical period in the nursing history, during which the mother and the infant are adapting themselves to each other. During this period there is great danger that the distress and lack of gain in weight due to underfeeding may be misinterpreted as improper feeding. The scale used for measuring the twenty-four hour intake, by weighing before and after each feeding and the estimation of the gain in weight over given periods of time, must be the determining factors for the institution of complemental feeding. In order to establish a maximum milk flow, both breasts should be given at each feeding, but at not too short intervals, and if other food is necessary it should be given after the nursing and not in place of a nursing. Such a procedure will result in a maximum stimulation. When, through any cause, the infant is unable properly to stimulate the breasts, regular expression should be practiced. Mothers are to be taught that lactation can be reestablished even after the baby has been off the breast for some time.

In private practice, in order to obtain the maximum breast feeding, it is necessary that routine consultations with the mother be inaugurated. These should begin shortly after the baby is born, by personal instruction to the mother as to the best means of promoting her breast milk supply through proper hygiene and diet, on her own part, and regular stimulation of her breasts by the baby or by expression of milk or a combination

of these methods. When the activities of the physician do not permit such instruction it should be given by a trained nurse or some one who has had practical experience along these lines.

In not a few instances, even in the presence of good breasts, during the first few weeks the breast milk supplied by the mother will not meet all the requirements of the infant, and occasionally this period of insufficient supply may run into the second month. In all such cases complemental [8] feeding becomes necessary. With improvement in the mother's general health and her assumption of her normal activities, the breast milk supply increases, and repeatedly we have seen what at first seemed a hopeless case for complete breast feeding develop into one in which the infant could be supplied with all of its needs until the time arrived at which mixed feeding was the diet of choice. Such cases are especially common among the very young and old primiparas, and these are the ones who require the greatest amount of encouragement.

It therefore becomes the duty of the physician, in order that the mother may assume her full responsibilities toward her infant, to see the infants in their practice at regular intervals during the period of lactation. Weekly or bimonthly consultations during the first month, and monthly visits during the remainder of the nursing period are not only to be recommended but in many instances are imperative for the best interests of the infant. Breast feeding is rarely considered a burden by the young mother when the four-hour nursing period has been established, and in case of emergency it is usually possible to express sufficient milk to satisfy infants, should it become impossible for the mother to be present at the feeding hour.

8. Complemental feeding is the administration of a bottle following a period at the breast; substitute feeding the replacing of a breast by a bottle feeding.

Disturbances in Breast-Fed Infants

Breast milk is a complete food and contains all the essentials of a well-balanced diet for the human infant. Notwithstanding the fact that there is a considerable difference in the chemical composition of milks from different sources, the average infant will thrive on them. However, nutritional disturbances are of common occurrence in the breast fed; and while, on the whole, they are less dangerous than similar disturbances in bottle-fed infants, they should receive early and serious consideration.

Those most commonly seen fall within one or more of the following groups: (1) underfeeding; (2) overfeeding; (3) congenital debility, with resulting impairment of the vital functions; (4) intercurrent parenteral (pharyngitis, tonsillitis, bronchitis, pneumonia, pyelitis, etc.), and enteral infections, and (5) idiosyncrasy toward mother's milk.

CHAPTER VII

UNDERFEEDING

The diagnosis will be dependent on an estimation of the quality and the quantity of milk received by the infant. The clinical picture as presented by the infant is the predominating factor that leads the physician to an investigation of the underlying elements causing its lack of progress.

The quantity of the twenty-four hour supply is ascertained by weighing the infant before and after each nursing without change of garments. An accurate beam scale should be used. Most infants require from 2 to 2½ ounces (60 to 75 c.c.) of breast milk per pound of body weight in twenty-four hours.

SYMPTOMS

Dissatisfaction on the part of the infant with its individual meals is usually the first evidence of underfeeding. This is usually followed by restlessness and crying before the nursing time is due. Again, it may manifest its dissatisfaction by nursing greedily for a short time, releasing the breast and crying. In some instances it cannot be induced to remain at the breast because of the difficulty it encounters in obtaining its food after the first few minutes; or, on the other hand, there may be a tendency to prolong its feeding time. These symptoms are usually soon followed by a period of stationary weight or a loss in weight.

Usually the stools are normal in appearance, but small in amount, and give little evidence of the cause of the trouble. However, if the food supply is decidedly insufficient, we may have a positive evidence of the underfeeding by the appearance of the so-called "hunger stools," which are brownish or greenish brown and contain little fecal matter and much mucus.

If the condition is not corrected, the baby becomes weak and apathetic. The skin loses its turgor, its temperature becomes subnormal, it is pale and anemic and the fontanels become depressed and the abdomen sunken. Whenever there is room for doubt as to the cause of this group of symptoms, the scale will furnish the most positive evidence.

TREATMENT

The first step necessary in the institution of a rational regimen is to ascertain whether the fault is to be found in the mother or in the infant. On the part of the mother, it may be due to her physical condition or lack of glandular tissue in the breasts. Or, again, the infant may have some deformity or infection of the mouth interfering with nursing, or it may be too weak to continue its nursing to the end. If the infant is not getting enough food, artificial food must be supplied, temporarily, as part of the diet.

Undue haste in removing the baby from the breast offers the greatest danger in the treatment of underfeeding and should be resorted to only when other means fail. The ability to increase the quantity of milk secreted by the average woman must necessarily vary directly with the quantity and quality of the glandular tissue composing the breast. However, to a certain extent at least, certain factors will more or less directly influence the quantity and quality of the secretion and they are worthy of our attention.

If the trouble is due to an actual insufficiency in the milk supply, careful attention must be paid to the hygiene of the mother. She must have plenty of rest and sleep, her surroundings must predispose to a happy frame of mind, she must not be overburdened with household cares and her exercise must be regular. If possible, she should be freed from all care of the baby

at night. She should eat sufficient food and drink plenty of liquids. Every effort should be made to stimulate her appetite, so that she will take an abundance of milk and other nutritious foods; but she should not be forced beyond her natural appetite, even in the taking of fluids. The general rules previously mentioned for the mother's diet should be followed. An excessive diet may be assimilated by the mother's body without increasing the flow of milk.

The diet recommended should be palatable to the nursing mother, as previously recommended.

Stimulating massage, combined with expression, may be applied to the breast in such a manner as to stimulate the whole gland. This can best be accomplished by two movements: By gently raising the whole breast from the chest wall and kneading it gently between the fingers, and by holding the breast against one hand and making circular movements against the periphery with the outspread finger-tips of the other hand and gradually working from its base toward the nipple.

Baths at a temperature comfortably cool (from 80 to 90 F.) should be taken daily to promote the mother's general health as well as cleanliness. These should be followed by a brisk rubbing with a coarse towel.

Steaming the breast by the application of hot towels covered with oil silk two or three times daily is of decided benefit.

Galactagogues are of questionable value. General tonics will often improve the digestion and tend to overcome anemia, and in this way improve the general health and thereby lactation. If after such methods the mother's milk is still insufficient, mixed feeding—part breast feeding and part bottle feeding—may be given for weeks or even months. One bottle feeding a day should be given in place of the breast, and the bottle should be given after each of the other breast

feedings to make up the necessary amount. The baby should be encouraged to empty the breasts.

When part breast milk and part cow's milk is given, a well baby will usually have no difficulty in digesting the cow's milk. In case the baby is disturbed or sick, the bottle can be stopped for a few days and the diet limited to breast milk and boiled water. Carbohydrates can usually be added to the water to advantage, in the form of cereals and sugars.

CHAPTER VIII

OVERFEEDING

In the normal breast-fed baby, overfeeding is not of frequent occurrence and is usually of temporary importance, except in very young and premature infants and in those infants fed by gavage. The condition is usually corrected spontaneously by refusal of the infant to nurse longer than is necessary to meet its needs. When the breasts remain unemptied, the milk secretion soon decreases. The temporary overfilling of the stomach is usually satisfactorily relieved by a regurgitation of part of the meal. There always remains some danger of the stomach's becoming accustomed to this tendency to reversed peristalsis. It is most commonly seen during the first weeks of life before the mother's breasts and the baby have become adapted to each other. Overfeeding in infants fed by gavage may lead to dilatation of the stomach when the food is too rapidly administered, and this may lead to grave symptoms.

ETIOLOGY

Too frequent feeding is the most common cause; less frequently, too prolonged feedings. Excessive quantities of milk from a free flowing breast are usually of temporary importance when the infant is nursed by the mother, but are more likely to be a factor when infants are nursed by a wetnurse, more especially when her breasts are kept active by the nursing of a second infant. Milk excessively rich in fat and sugar may lead to nutritional disturbances.

Ordinarily the stomach of a breast-fed infant empties itself in about two hours. The period between nursings during which the stomach is empty is one of considerable importance in that during this period, free hydrochloric acid is present. Besides its antiseptic properties,

it assumes an important rôle in stimulating the secretion of pancreatic juice and bile, both of which have an important bearing on digestion. Too frequent nursings interfere with these normal physiologic processes. Excessive quantities of food, even at proper intervals, impose too great demands on the gastric mucosa. When the food contains excessive quantities of fat, gastric secretion becomes diminished.

SYMPTOMS

The earliest manifestations of overfeeding are regurgitation, anorexia, irritability and, not infrequently, diarrhea. Regurgitation occurs at first only occasionally, immediately after nursing, and without any discomfort on the part of the infant (spitting). The regurgitated fluid is often unchanged milk. This is usually the first premonitory symptom.

Diarrhea follows when overfeeding continues and regurgitation becomes insufficient to rid the body of excess food. This is especially true when the milk is high in its fat and sugar content during the first weeks of life. The stools are more frequent than normal, and contain undigested particles of food. The irritating feces often cause intertrigo in the anogenital region.

In many cases no other symptoms develop, the condition undergoing a spontaneous cure. The breasts lessen their yield, and thus the cause of the condition disappears, or, on the other hand, the digestive power of the infant increases to such an extent as to be able to take care of the excess, if not too large. When, however, these disturbing factors are entirely neglected, the excess of the food continued, or even increased, owing to wrong interpretation of symptoms, then more serious symptoms develop.

Vomiting becomes habitual, occurring from a few minutes to half an hour after nursing. It is accom-

panied by visible discomfort and straining on the part of the infant. The vomitus consists of curdled milk, mucus and gastric juice. Between vomiting, there is often painful belching. The stomach shows distention, and empties itself only after three or four hours. Free hydrochloric acid is reduced or may be absent, the acid products of fermentation being present. The micro-organisms are increased in number and variety, owing to stagnation and absence of antiseptic free hydrochloric acid.

The weight early becomes stationary; in severer cases, associated with diarrhea, loss of weight becomes marked.

DIAGNOSIS

There is great danger of making a diagnosis of overfeeding in infants sick from other causes. As previously stated, it is, on the whole, a rare condition in normal infants. In the presence of symptoms suggestive of overfeeding, positive diagnosis is made by determining the amount of milk taken by the infant, and comparing it with amount an infant of the same age and weight should get.

If, however, the food is found to be quantitatively correct, occasionally information of value may be obtained by examining the quality of the milk chemically, especially as to its fat and sugar content. The specimen for examination should be taken under precautions pointed out under "Examination of Human Milk." By making a proper etiologic diagnosis, valuable indications for rational treatment are obtained.

COMPLICATIONS

Pylorospasm and gastric dilatation are not uncommon in the neglected cases.

Diarrheal disturbances are accompanied by the milder evidences of intestinal irritation, such as colic, and more

or less numerous bowel movements—acid and irritating, greenish-yellow, and containing numerous curds and much mucus. The buttocks soon become reddened, and intertrigo results.

Anhydremic intoxication, complicated by acidosis, while rare in the breast-fed infant, may result when the vomiting and diarrhea are neglected. The baby becomes drowsy and stuporous, pays little attention to its surroundings, and not infrequently develops an extreme anorexia.

In simple diarrheal disturbances, the intestinal findings dominate the picture, while in intoxication they share their prominence with the added nervous symptoms.

Eczema not infrequently results from overfeeding in the breast-fed infant, and is usually seen in the fat type of infant who is otherwise healthy.

Pyelitis is a frequent complication in neglected cases of diarrhea.

TREATMENT

The prophylaxis of this condition is of importance, and consists in giving the mother proper instructions as to the nursing, especially as to its frequency, and seeing to it that the rules covering the interval, number of nursings and time at the breast are observed. In wetnursing, more caution is necessary, especially in those wetnurses who have an abundance of milk, which is frequently the case in a wetnurse whose child is older then the infant nursed.

A very important point to impress both on the mother and on the wetnurse is the fact that crying of the infant is not always due to hunger, and that offering the breast should not be used as a means for quieting the child.

When the flow of milk is very free, it may be necessary to reduce the nursing period to even three to five

minutes, it being a fact that most infants take about 75 per cent. of their entire meals in the first five minutes at the breast. It is always well at the beginning of such an experiment to weigh the baby after a two, three, five, ten and twenty minute period to ascertain the exact amount which the baby obtains from the particular breast which it is nursing, so that conclusions may be drawn as to the time it is to be left on each breast. If the short nursing periods with increased intervals do not result in a lessened secretion and relief of the symptoms, the milk should be expressed and fed by hand in measured quantities.

When the breast milk contains an excess of fat, this is most easily remedied by reducing the mother's diet as a whole and increasing her exercise and water intake.

When the infant shows evidence of gastric distention and retention, the treatment consists in emptying the stomach and bowels of the overload of fermenting food, and resting the digestive apparatus, both these objects being achieved by giving a bland diet, consisting of boiled water, or weak tea sweetened with saccharin, for twelve hours.

If vomiting continues, it is advisable to wash out the stomach with physiologic sodium chlorid solution or 1 per cent. sodium bicarbonate solution.

Irrigation of the bowel aids in removal of fermenting intestinal contents.

CHAPTER IX

INTERCURRENT PARENTERAL AND ENTERAL INFECTIONS

Infections in the mother or infant may be the causative factors of nutritional disturbances. In the mother the most important are puerperal fever and sepsis, the acute infectious diseases, and local infections of the breasts. In the infant, infections outside the digestive tract, such as pharyngitis, tonsillitis, pneumonia, pyelitis and bronchitis, are classed as parenteral infections, and those of the intestinal tract as enteral infections.

SYMPTOMS

If the mother is ill, the clinical picture will vary, depending on whether the infant becomes infected by the contact, or suffers only through a diminished food supply. Conditions in the mother which would justify weaning have been discussed.

In conditions following infections in the infant, the symptoms depend on whether the infection is local, systemic or confined to the intestinal tract. The clinical picture varies directly with the degree of disturbance of the metabolic function. As a rule, the enteral infections are more commonly associated with grave disturbance of the infant's nutrition. Parenteral infections also interfere with the processes of metabolism necessary to meet the nutritional needs. Undoubtedly, in many of these a secondary enteral infection results from ingestion of bacteria from the upper respiratory tract.

The diagnosis of the primary seat of infection in the infant is of considerable importance in deciding the method of treatment.

TREATMENT

Parenteral infections rarely call for restraint in administration of food because of the associated anorexia, and the infant should be nursed (if possible without danger to the mother) directly at the breast.

In the case of enteral infections, it may be necessary to withdraw the maternal milk and replace it by a short period of starvation, to be followed by small quantities of breast milk, taken directly from the breast during short nursings, or it may be best to feed small quantities of expressed milk to the infant at regular intervals.

Not infrequently it becomes necessary to feed these infants by catheter in order to sustain them. This method of introducing their food should be begun sufficiently early to avoid a catastrophe.

Under no circumstances should they be placed on food other than the mother's milk when the state of her health and the quality of her milk permit.

Inert fluids, such as water, weak tea, broths made from young meat and young fowls, and cereal decoctions, should be given between feedings to insure a sufficient intake of water, the infant's age permitting. A careful record should be kept of the twenty-four hour quantity of all fluids administered, in order to insure the child a sufficient water and food administration.

CHAPTER X

IDIOSYNCRASY TOWARD MOTHER'S MILK

The cases in which the mother's milk is totally unfit for the infant's use are exceptionally rare. More recently, considerably more attention has been given to the effect of the mother's diet on the quality and quantity of her milk secretion. The instruction so commonly given to the mother to the effect that she may eat whatever she likes has, in the light of more recent investigations, shown need for modification. The effect of the diet of the mother on the milk must be considered under two headings; first, what foods disagree with the individual mother to the extent of affecting the quantity of her milk supply. The mother will be the best judge as to what foods she herself finds it desirable to eliminate from her diet because of an undesirable effect on herself. More important, however, from the standpoint of food idiosyncrasy is the result following the eating of foods by the mother which she herself may relish, but which may have an undesirable effect on the child. It is well known that eggs, some cereals, fish and sea foods, certain meats, chocolate, and even cow's milk proteins, when ingested by the mother, may result in a sensitization of the infant.

The more recent work of O'Keefe[9] demonstrated the frequency of such a sensitization in eczema. Sixty-one per cent. of forty-one cases showed a positive reaction to one of the cow's milk proteins. Forty-one per cent. showed a positive reaction to one of the egg-proteins, two cases to oats, and one to wheat. About 20 per cent. of the positive cases showed a response to both milk and egg proteins. Apparent cure in about 20 per cent. more followed the omission or limitation in the maternal diet of one or more food proteins to which the infant was sensitive.

9. O'Keefe, E. S.: Eczema in Breast-Fed Babies, Boston M. & S. J. **185**: 194 (Aug.) 1921.

Talbot[10] reports a case in which a very severe eczema cleared up on the mother's discontinuing the eating of chocolate, and recurred on her again eating that food.

By a series of experiments, Shannon[11] was able to demonstrate that two infants under his care, who were suffering from urticarial skin lesions, had become sensitized to egg protein ingested by the mother. He in turn sensitized a series of guinea-pigs by the injection of the breast milk from these women, and was able to precipitate anaphylactic reactions by intrathecal injection, when eggs were added to the mother's diet.

Cases of Egg Anaphylaxis.—The grandmother of a patient presented no idiosyncrasy following ingestion of eggs, until the time of her first pregnancy, when during the fifth month she ate eight eggs in one day. Since that time, twenty-four years ago, she never has been able to relish eggs. Her first child was unable to eat eggs or anything containing eggs during her childhood, but during her later years she has been able to eat food containing a moderate quantity of egg. She has no children. Her second child, the mother of the patient, gave the same history, stating that she could detect the smallest quantity of egg in pastry, at the first taste. The patient had been a well infant until seen at 8 months, when it was still exclusively breast-fed, and had developed a severe diarrhea. For twelve hours it was placed on barley-water, with instructions to add the white of one egg to a pint of barley water during the subsequent twelve hours. It partook of 1 ounce of this mixture of barley water and egg albumin. Within thirty minutes, it became violently ill, with vomiting and purging, and shortly thereafter developed marked edema of the entire body. This lasted for six hours, when it receded spontaneously. When a slight abrasion was made with a Pirquet scarifier, and a drop of egg albumin was applied to the abrasion, a white wheal, one-half inch in diameter, developed within six minutes, continuing to increase in size for fifteen minutes, when it was surrounded by an erythematous area, 1 inch in diameter; throughout this erythematous area, numerous pin-head sized white elevations developed. The entire reaction disappeared in one and a quarter hours.

10. Talbot, F. B.: M. Clin. N. Am. **1**: 985 (Jan.) 1918.

11. Shannon, W. R.: Demonstration of Food Proteins in Human Breast Milk by Anaphylactic Experiments on Guinea-Pigs, Am. J. Dis. Child. **22**: 223 (Sept.) 1921.

CHAPTER XI

CARE AND FEEDING OF PREMATURE INFANTS

Preparation for the care and protection of premature infants, in order to insure them the best opportunity for survival, must be started with the first intimation that labor is to begin, if spontaneous; and, when labor is to be induced, the infant, as well as the mother, should receive the best thought of the physician. The infant must be protected from the dangers of refrigeration, skilled nursing care must be supplied, and it must receive a suitable diet.

PRESERVATION OF BODY TEMPERATURE

Even though the mother may be so situated as to receive proper attention in the home, if facilities for caring for the infant are not at hand, the confinement should be conducted in a properly equipped hospital.

Syphilis should be suspected as a possible cause in all cases of premature birth.

The labor should be conducted with the strictest attention to asepsis, because of the high mortality following infections in this class of infants. Every effort should be made to prevent chilling of the infant immediately after birth. Owing to the instability of the heat-regulating centers, the infant's body temperature is rapidly affected by its surroundings. It should be received in a heated blanket and placed in an improvised heated basket or incubator bed, as soon as possible after the cord has been severed. The face alone should be left exposed. Protection is best afforded by a cotton pack, or, better still, by woolen garments. A nurse or another person experienced in the handling of infants should be assigned to the care of the baby and

give it her entire attention so that spells of asphyxia and cyanosis may receive the immediate attention of the physician. As a rule, the initial bath should be omitted until the infant, if it is a small one, has adapted itself to its new environment. Every effort should be directed to the prevention of overheating and burning infants, as they do not resist high temperatures to much better advantage than they do refrigeration, and they are easily burned; and burning, even though slight, would be associated with a high mortality. The room in which the infant is placed should be light and easily ventilated, without being cooled to a greater degree than may be desired. If the room temperature can be kept between 72 and 75 F., a well protected basket or crib can be temporarily heated to meet the infant's needs by surrounding it with hot water bottles placed a sufficient distance from and properly protected so that contact with the infant will be avoided. An electric pad protected by an insulated copper jacket will answer the purpose when placed under the pillow on which the infant rests. Suitably equipped obstetric departments are usually furnished with a heated bed as part of their permanent equipment. It is rarely necessary to surround the infant with a temperature greater than from 85 to 88 F., and usually it can be reduced to 80 F. in a few days except in the case of the smallest infants. A thermometer should be placed alongside the baby under the robes used as a covering.

Aseptic nursing is imperative to the welfare of these small infants. This applies to linens, clothing, thermometers and also utensils used in the care of the baby. During the bath, whether by sponging or by tubbing, it must be protected from chilling and infection, and of equal importance is the prevention of scalding. The water should be tested by allowing the hand to remain in the water for at least thirty seconds before placing

the baby in the bath tub, if it is to be tubbed. The baby should be bathed in a warm room. After the first dressing, all garments which come in contact with the body, except the napkin, should be made of a medium weight flannel, as the infant is best protected by woolen garments. As an outer garment it may be wrapped in a woolen blanket or one made from non-absorbent cotton between cheesecloth which has been quilted to protect it. A more permanent gown may be made of blanket material or eider-down in the form of a rectangle of sufficient size to surround the body and permit pinning over the feet. To this may be attached a smaller square at the top which will fold over the head and allow the face to remain exposed. A more permanent sleeping bag may be made of similar material. These have a disadvantage of requiring considerable handling of the infant for changing napkins and inspecting the genitalia. The most practical garments for the infant consist of a light-weight wool flannel undershirt with blind sleeves, so that the hands remain covered. Above this an overshirt of a heavier flannel or French piqué is to be worn. The extremities are wrapped in a flannel pinning skirt or blanket, fastened to the overshirt by small safety pins. The advantage of this type of clothing is that soiled napkins can be removed without exposing the upper part of the body, and the handling of the infant is at a minimum. A small pad of cotton should be placed inside the napkin so that the outer clothing may be better protected. The diaper should be changed as soon after soiling as possible, and this in itself will require regular inspection. It should therefore be dressed accordingly. The importance of properly clothing these infants becomes evident when consideration is given to the fact that they stand handling very poorly. As the infant becomes older, its clothing should be similar to those used in full term

infants so that it may have freedom for its extremities. The position of the infant should be changed at stated intervals in order to prevent hypostasis.

WORK OF THE NURSE

The nurse should appreciate the requirements of her charge. She must be willing to make necessary sacrifices while the infant is passing through its first critical days, and must be properly instructed to meet the emergencies of asphyxia and to counteract the spells of cyanosis. These will require almost constant diligence. She must also be possessed of good judgment in the matter of feeding, in order to avoid both underfeeding and overfeeding. She must also be able to appreciate the indications for and the methods of administering catheter feeding, as well as the simpler methods by use of the medicine dropper or miniature feeding flasks. She should be instructed in the proper preparation and tubbing of the infant for its bath, the giving of low colonic flushings, and the application of artificial respiration.

FEEDING

The majority of prematurely born infants will not survive artificial feeding; therefore, the difficulty in the interpretation of the needs of the individual infant should lead to the conclusion that a supply of breast milk is imperative to fulfil the food requirements of these infants in order to insure a low mortality. The administration of the feedings offers no difficulties which cannot be overcome if the infant is viable, persistent vomiting is absent, and breast milk is at hand. No definite rules can be outlined as to the quantity to be given at each feeding, and the same statement applies to the interval between feedings. This statement implies that each infant must be fed to meet its *individual* needs.

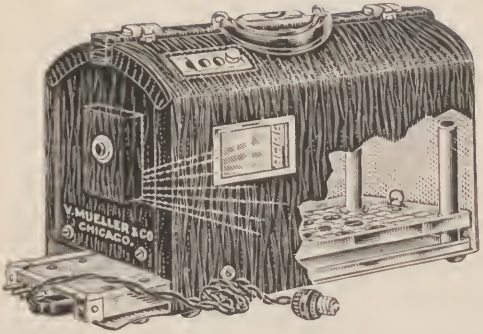


Fig. 6.—Bag for carrying prematurely born infants.

For the purpose of feeding, premature infants must be divided into two large classes: (1) those able to nurse directly from the breast, and (2) those which will require hand feeding. If the infant is sufficiently developed to nurse from a well formed nipple, it should be placed at the mother's breast two or three times during the second twelve hours after birth and, following this, at three-hour intervals. The nursing period should, however, be short at first, beginning with two or three minutes at the breast, as this will soon educate the child to expect its food at regular periods. It will also help to stimulate the mother's breasts, as well as to develop the infant's sucking muscles.

During the first days, until there is sufficient flow of milk, the infant must receive its breast milk from another source. The necessity of an early supply of food cannot be overemphasized, as even the better developed infants do not withstand prolonged starvation. When a wetnurse is available and her infant is at hand, her baby can be used to stimulate the breasts of the mother, and the premature infant can be placed on one of the breasts of the wetnurse. In the case of very weak infants, the breast designated for its use can be made to secrete more freely by placing the wetnurse's baby on the opposite breast during the feeding period. As a weak infant may receive only a very limited amount of milk, even after a prolonged period at the breast, a proper scale is a necessary part of the equipment, so that it may be weighed before and after feeding. There is far less danger from overfeeding because a too rapid flow or an excessive amount usually results in regurgitation, and this can easily be remedied by shortening the period at the breast. The capacity of the stomach in some of the smaller infants, even though they are able to nurse at the breast, is such that shorter intervals may be necessary. They may be nursed at two or two and one-half hour periods.

FEEDING DURING THE FIRST DAY

During the first day, milk may be withheld for twelve hours until the respiratory and circulatory functions are well established. During the second twelve hours, from one to three feedings of breast milk may be started if the infant's condition warrants.

FEEDING FROM THE SECOND TO THE TENTH DAY

For practical feeding purposes, the second to the tenth days may be grouped as the second feeding period.

From the second day the infant should be fed regularly, day and night, the number and time of feedings depending to a great extent on (1) whether the food is given with or without the use of a catheter; (2) the gastric capacity, and (3) the infant's general condition.

Further fluids, preferably inert, such as water or 1 per cent. lactose solution, are administered to compensate for the loss of body fluids through the kidneys, bowels, lungs and skin. The infant requires about one sixth of its body weight of water, inclusive of that contained in the milk, in twenty-four hours while in the heated bed. Such quantities, however, should not be attempted on the first days; usually it will be possible to approximate one eighth of the body weight by the fourth day. The early feedings must necessarily be small, and the increases gradual.

Each infant must be fed individually, as it is impossible to formulate definite rules for feeding, at least during the first ten days. The physician must have a definite idea of (1) the minimal food requirements for life; (2) the amount of food necessary to maintain at least a stationary weight, and (3) the amount of food needed to meet the requirements for growth and development.

Approximately one seventh of the body weight of fluids and human milk of a food value of 70 calories per kilogram every twenty-four hours are required to maintain life. Little can be expected in the way of weight increase until 90 calories is reached; and, depending on the weight, body surface, and physiologic development, the later needs of infants will approximate from 100 to 140 calories per kilogram of body weight.

Infants, to fulfil all their needs, will therefore require from 140 to 200 c.c. of breast milk per kilogram, or from one seventh to one fifth of their body weight daily. They can, however, maintain life on 100 c.c., and hold their weight in most cases on 130 c.c. per kilogram.

Beginning (in most cases by the second day) with from 20 to 40 c.c. of human milk per kilogram of body weight, the quantity may be increased by from 8 to 15 c.c. daily per kilogram until, usually by the tenth day, feedings averaging from 80 to 140 c.c. per kilogram can be fed.

These feedings should, as rapidly as possible, be supplemented by water or sugar-water by mouth, or saline by rectum to meet the required 140 to 200 c.c. per kilogram of fluids required daily.

After the *tenth day,* in larger infants the milk can be increased more rapidly, usually by 15 and occasionally 20 c.c. per day, until from 140 to 200 c.c. per kilogram are fed, the methods of giving the food, as well as its frequency, being dependent on the general development of the infant.[12]

The *size of individual feedings* will vary with the method of feedings. When the infant is *catheter* fed,

12. One kilogram equals 2⅕ pounds; 30 c.c. equals 1 ounce; 4 c.c. equals 1 dram; 1 ounce of breast milk contains 21 calories; 100 c.c. of breast milk contains 70 calories.

from six to eight feedings a day are given, with an average of from 4 to 6 c.c. for each feeding during the second day. The feedings are now increased daily by an average of 2 c.c. at each feeding. When feeding from the *bottle* or by *dropper* is employed, smaller feedings are usually given more frequently, usually from eight to ten daily, although twelve may be needed when larger feedings are not retained. Beginning with from 2 to 4 c.c., one may increase by 1 or 2 c.c. each feeding on each succeeding day, until from 140 to 200 c.c. per kilogram daily is reached.

The food and water to be administered should be noted in writing for the nurse's instruction each day, after a thorough inspection of the infant and its clinical chart.

The diet of a premature infant making a satisfactory gain in weight should not be changed arbitrarily without a well-defined indication.

Initial Weight Loss.—The lower the birth weight, the greater is the percentage of weight loss to be expected. Artificially fed infants lose more weight than breast-fed infants in whom the diet is started early. An average loss of not more than 8 to 12 per cent. of the birth weight may be considered satisfactory. By regular administration of inert fluids during the first days, the total loss can frequently be reduced to 5 per cent.

Daily Gains.—These are not necessarily in proportion to the changing quantity of milk administered, as many factors—the condition of the bowels, the quantity of urine passed, the temperature of the infant's surroundings, and numerous others — will necessarily influence the weight.

An average daily gain greater than 20 gm. is unusual when the infant's food is limited to one fifth

of its body weight. Although occasionally an infant holds its birth weight, most infants do not regain their birth weight before the end of the second or third week.

In the very small premature infants, an average daily gain of from 10 to 15 gm. with a doubling in birth weight in from seventy-five to 100 days may be considered satisfactory. In the larger infants, a gain of from 15 to 20 gm. may be expected with a doubling in birth weight in from fifty to 100 days. The birth weight is frequently trebled within 180 days.

SPECIAL FEEDING RULES

1. Food requirements which have been recommended must of necessity be considered as relative, variations being to a great extent influenced by the physiologic and anatomic developments and to a not inconsiderable extent by the temperature and humidity of the air surrounding the infant and the type of clothes in which it is dressed.

2. Each day the total amount of food as indicated for the individual infant is to be estimated, in order that the required food and water may be properly administered. The number and amount of feedings will of necessity vary, but each must also be estimated for each day.

3. When a number of infants are to be fed by one wetnurse, careful calculation of the day's needs of each infant must be made by the floor nurse for the information of the nurse in charge of the milk supply.

4. Expression of breast milk should be performed at regular intervals, preferably six times a day at four-hour periods day and night. The sixth expression during the night may, however, be omitted if the supply is in excess. It is only by regular and complete emptying of the breasts by expression that a milk supply

can be maintained for an indefinite period, unless there is a second baby which can be placed at the breast.

5. Human, as well as cow's milk, must be obtained under aseptic conditions and kept clean and cool until feeding time. To preserve milk properly, the icebox must register less than 50 F. The food should be slowly warmed before feeding.

6. The amount of water to be fed must be carefully calculated, and it must represent the difference between the total fluids indicated, which will usually average from one eighth to one fifth of the body weight of the infant for twenty-four hours and the amount of fluid given as milk. *The water for each day should be measured and set aside in an individual stoppered bottle each morning.*

It should be administered between the milk meals; or, occasionally, there may be an indication for diluting the milk with part of it. In order to administer the full day's water supply in some of the small infants and those who vomit, it may be necessary to give water in small quantities one, two and even three times between milk feedings. If the infant is unable to swallow properly, water must be given by catheter. In larger infants only a few water feedings a day may be needed, and usually by the second or third week, one seventh or one fifth of the body weight in milk can be fed daily. At this time the water may be discontinued unless it is necessary to supply external heat of considerable degree, or the infant has a fever, both of which necessitate increased amount of fluids.

FEEDINGS AFTER THE TWENTY-FIRST DAY

Usually by the twenty-first day, the food requirements of the infant are quite well established, and a careful observation of the infant's weight, stools, disposition and, equally important, its body temperature will decide the future requirements.

The water requirement will to a great extent be dependent on the supply of artificial heat and the presence of fever. Ordinarily by the beginning of the fourth week, from one seventh to one fifth (140 to 200 c.c., or from 100 to 140 calories per kilogram) of the infant's body weight in the form of breast milk is needed to maintain proper growth. Rarely is it necessary to exceed these amounts, even in the poorly nourished premature infant. If the physiologic functions are seemingly normal, *the scale* is the deciding factor in indicating food increases or decreases.

As the infant takes on weight and becomes fat with a rounding of the features and the body, as is the case in premature infants successfully fed with breast milk, the total milk administration can be held at one sixth and not infrequently one seventh of the body weight, and normal weight increases may still be maintained.

MIXED FEEDING

When human milk, even though in small quantities, is available, it should form the basis of the diet, and cow's milk mixtures should be supplemental.

ARTIFICIAL FEEDING OF PREMATURE INFANTS

A much higher mortality is to be expected when cow's milk replaces human milk in the feeding of premature infants.

When it becomes necessary to resort to artificial feeding, the quality of the cow's milk and other ingredients, the preparation of the mixture, and the quantity to be administered must all be given careful consideration.

Many different diets, such as simple milk dilutions, cream and skim milk mixtures, skim and buttermilk mixtures, malt soup preparations, condensed milk and evaporated milk, have been suggested. With each food, results are in large part dependent on the physician's knowledge of the results that should follow its use.

Ordinary milk, water and sugar mixtures are not well taken unless, by boiling or alkalizing the mixture, it is so modified that the curd becomes finely subdivided. Our best results have been obtained by the use of low fat and moderately high protein and carbohydrate mixtures.

A boiled buttermilk or skim milk mixture [13] to which dextrinized flour and cane sugar are added may be used to advantage. For use during the first weeks it may be prepared according to the formula given in Table 2.

The foregoing formula provides for 16 calories for each ounce, or 540 per liter.

TABLE 2.—*Mixture for Use During the First Weeks*

Buttermilk or skim milk	1,000
Flour (dextrinized)	10
Sugar (cane)	40

For later use it may be prepared as in Table 3.

All of the rules suggested for feeding with human milk must be rigidly observed both as to quantity and to frequency of feeding. In many instances it will be necessary to increase the diet even more slowly than suggested, and the infants must be carefully observed for evidence of overfeeding. It should also be evident that there is always great danger of underfeeding these infants when on an artificial diet. As soon as the infant's condition warrants the fat-free diet, buttermilk

13. The buttermilk and skim milk mixture is thus prepared: To a few tablespoonfuls of buttermilk or skim milk, 2½ level tablespoonfuls of dextrinized flour is added to make a paste. This is made up to 1 liter with buttermilk. (1) The whole is brought to a boil, and withdrawn from the fire. (2) It is brought to a boil again, and withdrawn from the fire a second time. (3) Four level tablespoonfuls of cane sugar is added and the mixture is brought to a boil for the third time. This process should take about twenty minutes. The mixture should be stirred constantly with an egg beater while over the flame. It is made up to 1 liter with boiled water, if the quantity has boiled away to a less amount. It is then put on ice. It is well to start with one-half the amount of sugar and increase as indicated, in the presence of loose stools. Maltose dextrin preparations may be used to replace the cane sugar.

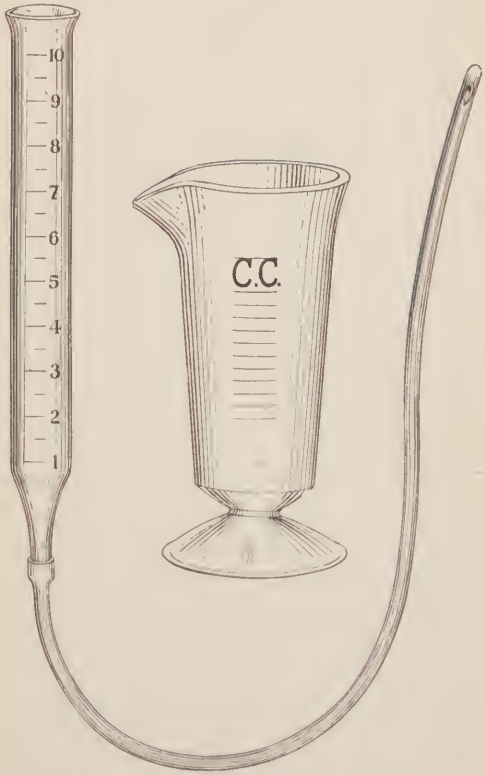


Fig. 7.—Gavage feeding: syringe barrel, catheter and graduated glass.

or milk is to be replaced in part by whole milk, or small quantities of cream should be added.

Cream can be added to the foregoing mixtures as indicated in Table 4.

Whenever it is possible to obtain even small quantities of human milk, the artificial food should be used only to supplement the breast milk.

TABLE 3.—*Mixture for Later Use*

Buttermilk or skim milk	1,000
Flour (dextrinized)	15
Sugar (cane)	60

This formula provides for twenty calories per ounce or 700 per liter.

TABLE 4.—*Formula with Cream*

Buttermilk or skim milk	950
Cream, 16 per cent	50
Flour (dextrinized)	15
Sugar (cane)	60

Other Dietetic Requirements.—To counteract the effects of boiling, orange juice feeding should be instituted by the third week, beginning with 0.5 c.c. (8 drops) and increasing from 2 to 4 c.c. (from ½ to 1 dram) daily by the eighth week, in order to avoid scurvy. Cod liver oil as an antirachitic should be fed by the fourth week, beginning with 0.5 c.c. (8 drops) daily, divided into two feedings and increased to 2 c.c. (30 drops) daily by the eighth week. It may be mixed with the orange juice. To counteract the low iron content of these diets, ferrous carbonate, 0.03 gm. (½ grain), or iron and ammonium citrate, 0.03 gm. (½ grain), once daily should be started by the fourth week. The latter may be prescribed in solution.

CHAPTER XII

THE ARTIFICIAL FEEDING OF INFANTS

A critical study of the work of the last fifty years in the artificial feeding of infants shows that the morbidity and mortality of infants has been definitely lowered. This has been brought about largely through a better understanding of the biology and chemistry of milk, and through applying to its collection and preservation the knowledge of the laws governing the incidence and growth of bacteria.

The progress during the last decade in the artificial feeding of infants may be summarized in the statement that the one great step that has placed their feeding care on a sound basis is that their physiologic requirements are now given first consideration. This has been made possible through a better understanding of individual needs in fat, protein, carbohydrates, salts, accessory food factors and water, to secure body growth and development.

General rules may be laid down for the average full-weight and robust infant (fortunately, in the majority) who only requires supervision over his reaction to a properly balanced diet. But there remains a considerable number comprising (1) infants born congenitally weak, and (2) infants who have developed pathologic conditions secondary to food disturbances and infections. These will require the *strictest individualization* in the selection and application of their diets.

If conclusions were drawn leading to the belief that our knowledge of artificial feeding is complete, great injustice would be done to the infant. Indeed, much is to be hoped for as our information on this subject advances, and this applies with equal force not only to the feeding of the exceptional and sick infant but also to the feeding of the normal child.

Laxity in the regulation of the feeding care of the infant during its first weeks is one of the greatest obstacles to a more complete success, for in this period the pathologic foundation is laid on which nutritional disturbances develop. The successful feeding of infants depends, therefore, on the recognition of the necessity of (1) a proper interpretation of the needs of the individual infant, and (2) experience on the part of the physician in meeting those needs.

HISTORICAL REVIEW

Very few records on the subject of infant feeding are available [15] antedating the fifteenth century. The first of these, issued in 1487 by Paulus Bagellardus, was entitled "De Aegritudinibus Infantum." The earliest book in English appeared in 1567, when Thomas Faier published "The Regimen of Life." During the eighteenth century a dozen or more books appeared. The output doubled in the first half of the nineteenth century. Artificial feeding, for example, as a substitute for the breast is not mentioned until the eighteenth century. Breast feeding was practically the only means of nourishing a young child. The infant had no choice but the breast either of its mother or of a wetnurse.

Bagellardus says that the mother (or wetnurse) customarily suckled her child for two or three years. Even in those days mothers, like many of their modern sisters, found that nursing interfered with their social duties, and those who could afford them were glad to shift their maternal duties to hired wetnurses or foster mothers. It is hard to realize in this day, when wetnurses are few and far between, how widely they were in demand in previous generations.

Infant deaths were common enough from natural causes. Yet artificial feeding, which is one of the

15. Mixsell, H. R.: Arch. Pediat. **33**: 282 (April) 1916.

most prolific causes of disease and death, was not practiced. With unclean houses and insanitary towns. hand feeding was still a deadly undertaking. Infant mortality was high, two fifths of the total deaths being of children under 2 years of age. During some years more than half the children born were lost from infantile diseases. No mention is made of artificial feeding, so that it cannot be blamed for this death rate.

Early in the eighteenth century, changes were in progress. If the mother could be supplanted, why not the wetnurse? Why not employ some other food than human milk? It was finally considered safe, about the middle of the century, to give water-pap as soon as the first tooth had appeared. Cow's milk was still objected to. The breast was not withdrawn altogether until the child was 2 years old. In the literature about this time appear the first recommendations for the use of cow's milk for supplemental feeding.

In a treatise entitled "On the Raising of Healthy Infants," published by J. P. Frank, in 1749, we read that von Swieten, Loseke and Cosner were the first to advocate diluted cow's milk for infant feeding. Frank advised dilution with either plain water, barley-water, wheat-water or oatmeal-water.

Ass's milk and animal broths seem to have had early use. John Armstrong, in "An Account of the Diseases Most Incident to Children," (London, 1783), recommends that the nursing child should take, in addition to the breast, pap or panada made from bread-crumbs boiled in water and sweetened with sugar. If the child was artificially fed from the start, it should have "cow's milk mixed with its victuals as often as possible and now and then a little of it alone to drink. Ass's milk will be still better." If the milk disagrees, he says, animal broths should be given. To assist teething and to promote the secretion of the salivary glands, a crust

of bread dipped in water or milk should be given to the child to suck.

Among English writers the next advance in methods of feeding is found in John Clarke's "Commentaries on the Diseases of Children" (London, 1815). This author was one of the first to advocate the employment of cream diluted with starchy concoctions; he also seems to have used whey as a beverage.

Michael Underwood, in his admirable (for the period) "Treatise on the Diseases of Children," which ran into ten editions (1811-1847), although influenced by hoary traditions, still endeavors to free himself from the prejudices of the age. He is the first who seriously attempted to find some substitute for breast-feeding.

In the edition of 1818 he says:

> It has, indeed, been universally lamented, that in no age has the study of the disorders of children kept pace with the advancement of science. Indeed, till of late years, little more has been attempted than getting rid of the wild prejudices and prescriptions of the old writers, which had served only to obscure the true nature of children's diseases. A very principle cause of the above-mentioned neglect has arisen from an ancient idea, for a long time too generally entertained, that, as medical people can have but a very imperfect knowledge of the complaints of infants, from the inability of children to give any account of them, it is safer to trust the management of them to old women and nurses, who, at least, are not likely to do mischief by violent remedies, though they may sometimes make use of improper and inadequate ones.

Recognizing the importance of choosing a milk as near as possible to mother's milk, he includes in his treatise two comparative analyses of the milk of women, cows, goats, asses, sheep and mares. The conclusions that he draws are that cow's milk is best suited for the ordinary case, but for the very young or in bad cases of diarrhea ass's milk is to be used,

as it is thinner and has far less curds than other milks. To this milk a diluent of barley water is suggested as an addition. This is the beginning of milk dilution, and marks another decided step in advance. Some years later other diluents besides barley were mentioned, the one most advocated being a small quantity of light jelly made from hartshorn shavings, boiled in water to the consistency that veal broth acquires when cold. To this was added a little Lisbon sugar, or loaf sugar.

The design of the jelly is obvious and rational, at once calculated to render the food more nutritive, as well as to correct, in some measure, the ascendency of the milk; this quality being thought to abound in the milk of different animals, in proportion to the quality of vegetables on which they feed. And the milk of quadrupeds, we know, is produced from vegetable juices only, while breast milk is formed by a mixture of animal and vegetable food. A little Lisbon sugar may be added to this compound of jelly and milk if the child be not inclined to a purging, or in that case a little loaf sugar, but the less of either the better. At first the milk ought to be boiled, to render it less opening; but when the child is several months old, or may chance to be costive, the milk need only be warmed. If it be fresh from the cow, and very rich, a portion of water may be added to it, whilst the infant is very young. Indeed, it ought to be as new as possible, since milk, as an animal juice, probably contains some fine subtile particles, which evaporate upon its being long out of the body.

Though I have said cow's milk is usually preferable to any other, it will be conceived that I mean for infants who are strong and healthy. Ass's milk, on the other hand, being more suitable for many tender infants during the first three or four weeks, or perhaps for a longer time, as well as for children who are much purged; as it is thinner and having far less curd than any other milk, it sits much lighter on the stomach, both of tender infants and adults.

Writing during this same period, Marriman states that "the attempt to bring up children by hand proves fatal to seven out of eight of these miserable sufferers; and this happens where the child has never taken the

breast, or, having been suckled for three or four weeks only, is then weaned."

For the diet of older children, Underwood gives broths, beef-tea, puddings made of bread, semolina, tapioca (new at the time), or rice and salep boiled in milk. Later he gives light meats, vegetables and "red wine" to counteract the tendency to rickets. All these during the first year in many cases. The weaning period was held to be about twelve months, or when the child had cut at least four teeth.

As infant feeding and infant mortality are so closely bound up together, the records of infant deaths should throw some light on the subject. From 1780 to 1816 (Forysthe), in London, there were 56,000 births and 19,000 deaths under 2 years of age, or approximately 34 per cent. Of these the mortality was 80 per cent. hand-fed, or seven out of eight. The Paris Foundling Hospital had a mortality of 85 per cent. of 32,000 infants, while in Dublin, of 10,000 children admitted to the hospitals during the years 1775 to 1796, only forty-five survived—in other words, 99.6 per cent. died —a simply frightful mortality. It is therefore plain why artificial feeding was regarded with such suspicion, and why it made such little headway.

The infant mortality of the time in America ran almost parallel to the European figures, being, if anything, less, owing probably to the outdoor life. Medical instructions to physicians gave but little help to the mothers, and the feeding of the infant was carried on haphazardly and on no scientific basis.

Dewees, writing in 1832, recognized the value of the application of heat to prevent decomposition of the milk, but advised against prolonged heat at a temperature at or above boiling:

> Boiling takes from the milk some of its best qualities. In hot weather, it is true, the tendency to decomposition is

diminished by boiling the milk. It is every way sufficient for the purpose of preservation that the milk be put closely covered over a hot fire and brought quickly to the boiling point; so soon as this is perceived, it should be removed and cooled as speedily as possible. By this plan we prevent in great part the formation of that strong pellicle which is always observed on the top of boiled milk, and by which the milk is deprived of one of its most valuable parts.

It was not until reorganization of the New York Medical College in 1860 that a special clinic for the diseases of children was opened. It was due to the efforts of Abraham Jacobi, the dean of pediatricians in this country, that this was brought about. Other medical colleges quickly followed suit, and by 1870 pediatrics and infant feeding in particular finally began to be placed on a scientific basis.

In 1858, Cummings[16] gave a clear exposition of what might be termed the forerunner of percentage feeding. But it was not until Biedert's work, published in 1869, that the real foundation for modern infant feeding was laid. Prior to this, most of the work was empiric, and the results obtained in substituting artificial for breast feeding were bad. Biedert's comparative analysis first proved that the protein of breast milk is less than half of that contained in cow's milk, and is of different quality. As a result of his laboratory and clinical investigations, he taught the basic idea that the casein of cow's milk when fed in large quantities resulted in digestive disturbances. He fed mixtures very low in casein, but with high fat and whey content.

John Forsyth Meigs, in 1885, enlarged on Biedert's work, believing, as did Biedert, that the casein in the milk caused much of the trouble in infant feeding. He further emphasized the need for a better knowledge of the amount of cream, sugar and lime water

16. Cummings: Am. J. M. Sc. **36**: 25, 1858.

to be added in his modification in order that the composition of human milk might be approached. This, in fact, was the real basis for the percentage method, which Thomas Rotch (1887) later developed and refined. Rotch believed that for the successful feeding of infants the modifications should be so gaged that they could be changed to meet special indications. He was the first to emphasize the need of individualization and to show the necessity of fully considering all of the food elements in the diet. He taught us that fat and sugar, as well as protein, were important factors in the disturbances of artificially fed infants. His work on percentage feeding, that is, increasing or decreasing the various constituents of human milk to meet definite clinical conditions, was probably the first epoch-making advance in infant feeding, and his system has since been known as the percentage method.

Following the teachings of Jacobi, Meigs and Rotch, the further development of scientific infant feeding was for many years essentially American. Possibly the chief criticism that can be offered on the early feeding methods is that, as shown in the light of later experience, too great consideration was paid to the food itself, more especially to its casein content, and too little to the infant. Notwithstanding this, these early careful investigations greatly aided in lowering infant mortality.

The German school, of which Rubner and Heubner were the chief advocates, brought forward the so-called "caloric method" of feeding, by which they sought to provide the number of heat units required by the infant, basing their estimations on the infant's weight. This method will be discussed later. We do not now use this method, but a check on the caloric content of the food is of inestimable worth in determining the value of our mixtures, for avoiding overfeeding and

underfeeding. The German school has never attempted such refinements in the percentage composition of their mixtures as are advocated by the American school.

More recently, Czerny and Finkelstein have emphasized the dangers of overfeeding with whole milk, and also with its individual ingredients, fat, sugar and salts, separately or in combination. Their studies have, on the whole, ignored the proteins, probably because protein disturbances other than those seen in infants suffering from a milk idiosyncrasy mostly occur in infants fed on raw cow's milk, while the greater number of the continental clinics have for several years fed boiled milk. Their studies and conclusions will be more fully reviewed in the discussions of the disturbances of artificially fed infants.

In American clinics during the last few years, there has been an increasing tendency toward boiling cow's milk before feeding it to the infant. This is in order to make the curd more fragile, and to destroy the pathogenic bacterial content of the milk as well. While this method has many advantages, it must not be overlooked that boiling causes definite changes in the milk, more especially as regards the soluble albumins, ferments and vitamins, which are of essential importance to the human economy. Fortunately, these can largely be overcome by the early administration of fruit and vegetable juices, nondextrinized cereals and other foods, such as cod liver oil.

CHAPTER XIII

COW'S MILK AND GOAT'S MILK

It cannot be too strongly emphasized that artificial feeding must not be considered as a substitute for breast feeding but only as an emergency measure. The best alternative is feeding with properly modified milk of other animals, and, for practical reasons, cow's milk and goat's milk have been found best suited for this purpose. Because of the marked chemical, physical and biologic differences between human milk, and cow's and goat's milk, human milk is superior to the others in infant feeding. The differences are greater than Table 5 indicates.

TABLE 5.—*Comparative Analysis of Breast, Cow's and Goat's Milk*

Reaction	Human Amphoteric or Alkaline	Cow's Amphoteric or Acid	Goat's Amphoteric
Specific gravity	1.010 to 1.040	1.029 to 1.034	1.030
Proteins	1.5 to 2.0%	3.5%	3.76%
Caseinogen	0.5 to 0.75%	3.02%	2.87%
Lactalbumin	1.23%	0.53%	0.89%
Effect of rennin	Clots in fine curds	Large curds	Large curds
Fat	3.5 to 4.0%	4.0%	4.0%
Lactose	6.0 to 7.0%	4.5%	4.5%
Salts	0.2%	0.75%	0.85%
Total solids	12 to 13%	13 to 14%	13.0%
Water	86 to 88%	86 to 87%	86 to 87%
Bacterial content	Practically sterile	Never sterile	Never sterile

COW'S MILK

Cow's milk is more opaque than human milk, although the latter may contain a greater percentage of fat. This is due to the opacity of the calcium-casein, present in greater proportion in cow's milk. Cow's milk is faintly acid or amphoteric when freshly drawn, but ordinarily is distinctly acid in reaction when consumed. Human milk is amphoteric or alkaline.

Three times as much protein is found in cow's milk as in human milk. The reason for this is obvious when we recall that the ratio of growth of the calf to that of the infant is about as 2:1. Furthermore, the protein in cow's milk consists chiefly of casein (3.02 per cent.) and a little lactalbumin (0.53 per cent.), while human milk contains from 0.5 to 0.75 per cent. of casein and 1.23 per cent. of lactalbumin. The sugar in the two milks varies greatly in amount but not in kind. Cow's milk contains more than three times the amount of inorganic salts in human milk.

Infants on whole cow's milk, therefore, live on a higher plane of mineral metabolism than infants on breast milk. Owing to a similar proportionate content of salts in the two milks, simple dilution, while equalizing most of the salts, will leave others either in excess or insufficient. Fortunately, excessive amounts of milk salts are rarely harmful to normal infants, as those in excess of the body needs are excreted. The greater danger lies in mineral starvation or a diet improperly balanced in its mineral content. The importance of salts to body function and growth in the artificially fed infant will be considered later in detail.

There is no great difference in the average amount of fat in the two milks; however, both in human milk and in cow's milk fat is the most variable constituent.

The curd from cow's milk is usually tougher and forms in larger masses than in human milk. There are also differences in antibodies, ferments, etc.

Protein.—The protein in cow's milk consists of insoluble calcium caseinate and soluble lactalbumin, lactoglobulin, mucin and opalisin. Of these, the casein (85 per cent.) and lactalbumin (15 per cent.) form the greater part of the protein content, the others existing in negligible quantities.

Casein.—This is in suspension, and is rapidly precipitated by weak acids and by rennin, but it is not coagulated by boiling. The casein of raw cow's milk precipitates as large, tough curds, thereby differing from the fine, flocculent curd of human milk. The physical properties of cow's milk curds can be changed by boiling the milk, and by adding alkalis, such as sodium citrate, sodium bicarbonate and lime water. Following such additions, the curd becomes finely divided, resembling the curds of breast milk. By the addition of cereal water in the milk dilution, a similar effect is obtained through the mechanical fragmentation of the curd by the interspersed starch particles. Splitting of the curd shortens the period of digestion, the finer curds passing the pylorus more readily, which brings them in contact with the intestinal juices in a shorter time.

Lactalbumin.—This is not coagulated by acids or by rennin, but is coagulated by heating to 72 C. or higher.

Fats.—The fat is suspended in the milk serum as an emulsion. The droplets or globules vary in size; on the average, they are smaller in milk from Holstein than from Jersey, Guernsey or shorthorn breeds. The fat droplets are lighter than the milk serum and therefore rise on standing (gravity cream), or they may be readily separated by centrifugal force (centrifugal cream). The chemical composition of the fat of cow's milk differs from that of human milk in that it contains more tripalmitin and less triolein. This difference is of practical importance, since the calcium and magnesium soaps of palmitic acid are much less readily absorbed from the intestinal tract than are the soaps of oleic acid. Cow's milk also contains a considerable proportion of glycerids of the lower or volatile fatty acids, which under certain circumstances may irritate

the intestinal tract, resulting in diarrhea. Not only is there difference in the size of the fat droplets from certain breeds of cattle, but the average total fat content varies very materially. The average fat content for different herds as given by Van Slyke and Publow,[17] is reproduced in Table 6.

Lactose.—This is the principal sugar in both cow's and human milk, its chemical composition in the two being identical. Average human milk contains from 6 to 7 per cent., and cow's milk from 4 to 5 per cent. The larger sugar content of human milk, with its fermentation, accounts for the laxative effect of breast-milk feeding when the milk is abundant.

TABLE 6.—*Fat Content of Milk of Various Herds*

Breed	Fat Percentage
Holstein-Friesian	3.26
Ayrshire	3.76
American Holderness	4.01
Shorthorn	4.28
Devon	4.89
Guernsey	5.38
Jersey	5.78

Salts.—Salts are necessary in digestion and in every step of metabolism, from absorption to secretion and excretion. The rôle of salts in both normal and pathologic conditions has assumed increased importance under the investigative studies of the last few years.

Human milk contains 0.2 gm. of ash in 100 c.c., and cow's milk 0.75 gm. The difference in percentage in human and in cow's milk is equalized, as the body uses only what is necessary for its life and growth.

All the salts except those of iron are in larger amounts in cow's than in human milk. Cow's milk contains relatively a very large amount of calcium phosphate, while the amount of iron in cow's milk is less than that in human milk. Human and cow's milk

17. Van Slyke and Publow, quoted by Heineman (Footnote 24).

differ greatly in the form of the phosphorus content. In human milk, three quarters of the phosphorus is in organic combination, while in cow's milk only one quarter is so combined. Neither in human nor in cow's milk is the iron content sufficient to meet the demands in the first year of life; the infant must depend on the iron stored during the fetal life.

The percentages and grams of the different salts of human and cow's milk, as found in 100 parts of ash, are given in Table 7.

TABLE 7.—*Salts of Human and of Cow's Milk*

AVERAGE PERCENTAGES OF DIFFERENT SALTS IN THE ASH							
	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl	Fe
Human milk.....	23.3	3.7	16.6	7.2	28.3	16.5	0.00015*
Cow's milk.....	23.5	2.8	26.5	7.2	24.9	13.6	0.00007*

GRAMS OF SALTS FOR EACH HUNDRED CUBIC CENTIMETERS OF MILK							
	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl	Fe
Human milk.	0.0458	0.0074	0.0345	0.0132	0.0609	0.0358	0.00017*
Cow's milk..	0.172	0.02	0.2437	0.0465	0.1885	0.082	0.00007†

* Holt, L. E.; Courtney, A. M., and Fales, H. L.: A Chemical Study of Woman's Milk, Especially Its Inorganic Constituents, Am. J. Dis. Child. **10**: 229 (Oct.) 1915.

† Langstein and Meyer: Säuglingsernährung und Säuglingsstosswechsel, Wiesbaden, J. F. Bergman, 1914, p. 22.

In all the constituents except phosphorus pentoxid and iron, the percentages of the different salts in the two milks are practically the same. The higher proportion of phosphorus in cow's milk is due to the large amount of casein. While the *proportion* of salts in cow's milk is nearly the same as in human milk, the *amount* is about three times as great. Unless, therefore, cow's milk has been diluted with more than twice its volume, these inorganic constituents are furnished to the infant in equal proportion to that in human milk (Holt). Human milk contains about twice as much iron as cow's milk, and dilution of cow's milk results in a decrease in the iron content which must not be carried too far unless supplemented by other iron-containing food.

Ferments.—Cow's milk contains a number of ferments, but little is known of their value to the infant. Escherisch and Hamburger thought that they had a favorable influence on the processes of metabolism. Salge discovered that tetanus and diphtheria antitoxins could be utilized by the infant only when found in human milk, while when contained in the milk of other species they did not get into the body fluids.

Vitamins.—Cow's milk contains fat-soluble A in considerable quantity, and water soluble B and C in lesser amounts.

Bacterial Content.—The bacteria of cow's milk vary in kind and number, depending on the conditions under which the milk is collected, preserved and handled. While human milk may be either sterile or have a low bacterial content, cow's milk is never sterile, and only too frequently, through carelessness, the original flora multiply rapidly. Certified, pasteurized and sterilized milk was the practical outcome of the efforts made to obtain germ-free milk for infant feeding.

The harmful or undesirable micro-organisms occurring in milk are of two classes. (1) Those that are definitely pathogenic and capable of producing infectious disease. Examples are the typhoid and dysentery groups, the tubercle bacilli, the virus of scarlet fever and *Bacillus abortus.*[18] (2) Saprophytic bacteria, some of which decompose milk and form products capable of causing gastro-intestinal disturbances.

Of the nonpathogenic organisms, those most frequently found are the lactic acid-producing bacteria. The most common types are: *Streptococcus lacticus, Bacillus lactis-acidi, B. Lactis-aerogenes, B. bulgaricus, B. acidophilus* and *B. bifidus.* The micro-organisms producing only lactic acid are mostly harmless, and the

18. Fleischner, E. C., and Meyer, K. F.: Bacillus Abortus, Bovinus in Certified Milk, Am. J. Dis. Child. **14**: 157 (Sept.) 1917.

lactic acid itself in the amounts produced in milk does not cause diarrhea when fed. In fact, the production of lactic acid leads to the destruction of many of the more harmful varieties of bacteria in milk.

The butyric acid group is also frequently present. This group produces butyric acid by its action on sugar and fat. Another group frequently found in milk are the proteolytic bacteria, which coagulate the milk and may cause a further splitting of the protein. *Bacillus coli,* which, as well as others, has the property of producing lactic acid; *B. proteus, B. alkaligenes,* the hay bacillus, *B. aerogenes-capsulatus* and others belong to this group. Most of the latter are sporebearing.

Slime-forming bacteria occasionally invade the milk. Among the most tenacious of these is *B. lactis-viscosi. Streptococcus lacticus* occasionally causes similar changes. At times the milk becomes bitter, because of the formation of peptones by contaminating organisms. Certain vegetables and plants may cause a similar taste in the milk. Occasionally a milk of reddish color is seen. This may be due to blood from the udder, or to the action of *B. prodigiosus.* A blue milk is even more common, and is due to *B. cyanogenes.* Protein and carbohydrate splitting yeasts and molds not infrequently invade the milk and cause changes that become more evident as the milk grows older.

GOAT'S MILK

Goat's milk is pure white, without especially pronounced odor or taste. There may be a peculiar "goaty" taste and unpleasant odor to the milk, but this can be entirely avoided if the milk is properly produced and handled, that is, by preventing manurial pollution, by keeping male goats out of and away from the stable in which the milking is done, and by taking precautions to keep the udder clean.

There is no essential chemical difference between the constitution of goat's milk casein and that of cow's milk.[19] The casein coagulum forms a more compact, firm mass than does that of the bovine.

Because of the similar chemical composition, goat's milk may be modified, like cow's milk, for infant feeding.[20] The protein content is considerably higher than in human milk, the sugar considerably less. The fat varies from 2.5 to 7.5 per cent.,[21] generally a little higher than that in cow's milk. The butter fat is white, there being a minimum of pigment.[22] The fat rather closely resembles the fat in human milk. The fat globules are relatively small, in very fine droplets,[23] and of uniform size. Ninety per cent. of the fat globules of cow's milk are over 4 microns in diameter; in goat's milk only about 10 per cent. are over 4 microns, and often 50 per cent. are under 2 microns.

The fat globules rise slowly, and in most cases no cream layer is formed. The cream is separated with difficulty by centrifuging,[24] but may be thoroughly separated in a cream separator. Goat's milk fat is richer in insoluble volatile acids than cow's milk fat; but, on the whole, there is very little difference when the chemical composition of the two fats is compared.[25]

In regard to the salt content, goat's milk differs[26] from cow's in containing tricalcium phosphate, dimagnesium and trimagnesium phosphate, monopotassium phosphate, and no monomagnesium or dipotassium phosphate. Human milk contains no insoluble phos-

19. Calvin, J. K.: Arch. Pediat. **38**: 584 (Sept.) 1921.
20. Griffith: Diseases of Infancy and Childhood **1**: 109, 1919.
21. Vieth: Milchztg. **14**: 449, 1885.
22. Schaffer: Schweiz. Wchnschr. f. Pharm. **31**: 58.
23. Barbellion: Verhandl. f. Kinderh. **13**, 1900.
24. Heineman, P. G.: Milk, Philadelphia, W. B. Saunders Company, 1920.
25. Solberg: Jahrb. f. Thierchem. **25**: 214.
26. Bosworth and Van Slyke: J. Biol. Chem. **24**: 173, 177 (March) 1916.

phates. Goat's and cow's milk contain more phosphorus than human milk. There are more chlorids in goat's than in human or in cow's milk. The different salts appear to be greatest in number in goat's and least in human milk. McLean [27] asserts that goat's milk contains more iron than cow's milk.

Yield.—In proportion to its body weight, the goat produces about twice as much milk as the cow. The goat may yield from ten to twelve or even fifteen times its body weight in milk yearly, while a cow yields five or six times its weight.[28] By good feeding, 800 kg. or more (from 600 to 1,100 liters) of milk may be obtained in a year. A year-old goat will produce from 300 to 700 liters a year.[29] Goats usually provide milk about six months out of a year, and a lactation period ranging from seven to ten months is considered very satisfactory. A good scrub or common goat will yield about 2 quarts (liters) of milk a day,[30] and a production of 3 quarts a day is considered excellent. However, a good grade Toggenburg will produce from 3 to 4 quarts, and some pure-bred Toggenburgs will run from 5 to 7 quarts a day.

If goat's milk is aseptically obtained, it is the most suitable substitute for breast milk, since it has not been exposed to the possibility of changes, has not lost its natural properties, and can be given raw.

Another advantage of goat's milk is that it cannot be skimmed, as the cream does not form a distinct layer.[31]

Goats are practically immune to tuberculosis.[32] Only from 0.4 to 0.6 per cent. of the goats in Prussia gave a positive reaction for tuberculosis.[24] The question

27. McLean: Ztschr. f. Kinderh., Orig. **4**: 168, 1912.
28. Fleischman: Lehrbuch der Milchwirthschaft **2**: 65, 1898.
29. Kohlschmidt: Jahrb. f. Thierchem. **30**: 254, 1901.
30. Rosenau: The Milk Question, New York, Houghton, Mifflin Company, 1912.
31. Kochen: Steinegger, Milchztg. **27**: 356, 1898.
32. Richter: Berl. klin. Wchnschr., 1888, No. 18.

of the transmission of a passive immunity to tuberculosis by the transfer of natural antibodies from goat's milk to very young infants, or from the use of this milk over a much longer period, is now being investigated. At present the results are incomplete.

From some very limited data it might appear that goat's milk is considerably higher in antiscorbutic properties than cow's milk. Moore states that six guinea-pigs weighing from 110 to 145 gm. each were fed on fresh goat's milk, one set for eighty days, a second for forty-four days. The animals developed normally with no clinical symptoms of scurvy, although similar experiments with cow's milk resulted in scurvy.

CERTIFIED MILK

The term "certified milk" should be limited to milk produced in accordance with the requirements of the American Association of Medical Milk Commissions.[33] The expressed desire of the dairyman to contract to produce clean milk is far from sufficient for public protection. Only by periodic inspection by representatives of the local authorities, such as city, state or special commissioners, can a supply of wholesome milk be continuously assured. Sanitary stables and proper handling of the cows, with milking into sterilized receptacles are prime essentials. The cows must be in good health, free from tuberculosis and other infectious diseases. All persons coming in contact with the milk must exercise scrupulous cleanliness and must be free from infections which might be conveyed to others through the milk. All of these precautions can be nullified by carelessness in handling the milk, either at the farm, during transportation or in the home. Certified milk must have a minimum bacterial content,

33. The standards are given in the literature of the American Association of Medical Milk Commissions.

and should never be more than thirty-six hours old when delivered.

Certification must be denied all milks having, on repeated examination, a bacterial count exceeding 10,000 per cubic centimeter. Such examination should be made at least once a week. Of even greater importance than the number are the types of bacteria found in the milk. The milk from all sick cattle and those with open wounds must be excluded. Employees suffering from infectious diseases which may contaminate the milk must be quarantined, and if contagious diseases occur on the premises of a certified dairy, the customers should be notified so that the milk may be sterilized in the home if the commission shall deem it wise to allow the milk to be delivered. In case of doubt, the dairy should be temporarily stopped from further deliveries. The milk must be cooled immediately after being secured, and maintained at a temperature between 35 and 40 F. until delivered.

Many good milks are spoiled on the door-step of the home between the time of delivery and of placing the milk in the icebox. All the utensils and vessels used for preparing the mixture must be clean and sterilized by boiling. As soon as the mixture is prepared, it should be put into the icebox again and kept there, preferably in individual bottles containing single feedings.

PASTEURIZED MILK

Pasteurization is accomplished by heating milk for a definite length of time, varying according to the temperature to which the milk is heated. The "holding method" whereby the milk is heated to not less than from 140 to 150 F., (60 to 65 C.) and is kept at this temperature for at least twenty minutes, is probably the most efficient for commercial purposes. Pasteurization in the home is well accomplished by one of several sim-

ple pasteurizers obtainable in the market. Similar results may be obtained by placing milk in the inner vessel of a double boiler with cold water in the outer vessel. The water is then heated to 160 F., and the milk is allowed to stand in its receptacle in a warm place for twenty minutes, following which it is rapidly cooled in a good icechest, where it should be kept until the time for reheating at feeding periods. If a similar method is desired for pasteurization in individual bottles, they should be placed in a pail, and water added to a level above the milk contained in the bottles, after which the water is heated to 160 F. The pail is then removed from the stove, covered, and kept in a warm place for one-half hour, after which the milk is to be rapidly cooled in a good icebox. It should be remembered that the bottles must be properly stoppered.

Scalded Milk.—The milk is heated in an open vessel until it bubbles around the edges and steams in the center. By this means it is heated to temperatures varying from 165 to 185 F. Scalding is not boiling.

Boiled Milk.—Milk may be boiled in either a single or a double boiler. With a single boiler, the milk is heated to the boiling point and allowed to boil from three to five minutes, with constant stirring. With a double boiler, the milk mixture in the inner and cold water in the outer vessel, the water is brought to the boiling point and kept boiling for from six to eight minutes; the whole process requires from ten to twenty minutes. Following the heating, cold water should be substituted in the outer vessel, and should be renewed several times until the milk cools. The milk is then put in small sterilized bottles for individual feedings, or in one large bottle, capped, and placed on ice. While milk heated in a double boiler forms a much finer and softer curd than that of raw milk, it is not so fine as the milk boiled directly over the flame. It does, however,

answer the needs in most cases, and, because of the simplicity of the method, is preferable.

RAW MILK VERSUS HEATED MILK

Whatever opinion one may have as to the advisability of recommending heated milk rather than raw milk for infant feeding as a general practice, it must be recognized that the earlier teaching in America concerning raw milk feeding led to the production of certified milk, with a resulting decrease in infant mortality. However, it should be emphasized that any method of food preparation which may tend toward an erroneous feeling of security is to be avoided. This applies particularly to milk production, as it is obvious that unclean milk cannot be considered a safe food for infants, even though it is pasteurized or boiled.

Raw Milk.—In large communities, certified milk from properly inspected dairies is the only milk which may be fed raw with any feeling of safety. During the warm months, even certified milk should be pasteurized or boiled in the home. In small communities, when the milk has been produced under sanitary conditions and reaches the home a few hours after milking, it may be safely used. When there is any doubt as to the quality of the milk, it should be heated.

PASTEURIZATION VERSUS BOILING

The ardent advocates of pasteurization claim that it is essentially a raw milk, so far as concerns its physiologic properties. Our experimental studies have shown that when milk is allowed to stand for some time after pasteurization, even though the vitamins are not completely destroyed, its antiscorbutic value is less than that of fresh raw milk. Therefore the relation of the time of pasteurization to the hour of feeding is important. Proper pasteurization destroys most organ-

isms except the spore bearers. Fortunately, this includes the majority of the ordinary pathogenic bacteria. One disadvantage is that most of the lactic acid-producing bacteria are destroyed, and, therefore, the milk fails to sour, or sours less readily than unheated milk. This may give the mother a false feeling of security. In most instances, however, some of the lactic acid-producing organisms, having a high thermal death point, survive the heating and thereby lead to souring in old milk. While commercial pasteurization, therefore, has its disadvantages, on the whole its use has accomplished much in the lowering of infant mortality.

Boiling in the Home.—This has the great advantage over commercial pasteurization in that if the raw milk has soured before it reaches the home, the housewife can readily detect it. However, it is to be remembered that many pathogenic organisms may develop in milk without giving any evidence of their presence; and, while the organisms themselves are in most instances destroyed by boiling, their toxic products are not thus removed.

The small flocculent curd of boiled milk is more easily digested than the large, tough, casein curds of raw milk. This is of distinct advantage in indigestion and diarrhea and in atrophy, as larger amounts of food and a more highly concentrated mixture can be administered. Boiling, therefore, effectually disposes of the majority of bacteriologic problems, and is an excellent casein modifier. While some of the lactalbumin is coagulated, small amounts of the sugar are caramelized, and some cream and salts are lost in the scum the advantages of this method outweighs its shortcomings.

In feeding boiled milk to infants, the danger of the development of rickets and scurvy can be positively obviated by the early addition of cod liver oil and

orange juice to the diet. A tendency to constipation develops, owing to the more complete digestion of the fine curds in the small intestine and the absence of the large, hard protein curd seen with raw milk feedings; but this can usually be counteracted by adding carbohydrates to the mixture. *Duly considering all these facts, we believe that whenever there is any doubt as to the quality of the milk supply, the method of choice is boiling in the home, preferably by the double boiler. This should also apply to the reboiling of pasteurized milk whenever doubt exists as to its quality.*

FROZEN MILK

Vomiting and not infrequently diarrhea follow the feeding of milk that has been frozen. So far as possible, it is better to avoid the use of milk of this type. As this is not always possible, such milk should be boiled before being used in the feeding mixture. In most instances, the changes are in all probability physical, for in the freezing of the water the emulsion breaks and the fat becomes separated. When the milk is thawed, the fat globules coalesce and form a thick layer of butter fat which may cause a gastric and intestinal upset. Milk that has been frozen is less likely to show changes in the fat emulsion if the process of thawing goes on slowly in a cool room.

Pennington [34] and her collaborators also found that changes occurred in the protein of milk that was held for a considerable period at a temperature of 0 C. These changes resulted in proteolysis of the casein and of the lactalbumin.

34. Pennington, Hepburn, Witner, Stafford and Burrell: J. Biol. Chem. **16**: 331, 1913.

CHAPTER XIV

CLINICAL ASPECTS OF INFANT FEEDING

The general well-being of the infant is as important as the percentage and energy value of the food formula. In considering the two important factors in successful feeding, the chemical composition is as essential as the caloric value. Otherwise one encounters profound disturbances, difficult of interpretation, and due to feeding of either insufficient or excessive amounts of the components of the diet.

The infant, therefore, must be fed amounts of fat, protein, carbohydrates, salts and water suitable to its constitution, age and physical development; these ingredients must be in proper proportion and sufficient in quantity to meet the caloric requirements of the young tissues for growth and development. The fact also must not be overlooked that the constituents of the diet must be in such form as will allow of normal digestion and assimilation.

The wide range of tolerance of infants to their food has been mentioned, and that this, probably, largely accounts for the fact that so many pediatricians have successfully fed infants on mixtures which varied greatly both quantitatively and qualitatively. In all probability another factor is important in the explanation of these successes, namely, the fact that to a certain extent fats, carbohydrates and proteins are interchangeable in the metabolic functions.

The Weight Curve.—In constructing a diet for infants, the individual needs must always be borne in mind. Allowance must therefore be made for basal metabolism, for growth, for muscular activity, and for the food values lost in the excreta (Holt). Indirect evidence as to the child's progress is best obtained by

taking a careful history of its illnesses and feeding history. Direct evidence is best obtained by a careful study of the infant's physical development and weight curve. One soon learns that a study of the infant's weight is one of the simplest and most reliable clinical factors in estimating its progress. While infants vary considerably in their reaction to a given diet, according to their birth weight, subsequent care and previous diet, definite information of inestimable value is to be gained through the regular use of the scale.

For practical purposes it is necessary that we know the average gain to be expected in normal artificially fed infants. It should be remembered that the breast-fed infant will average larger gains than the bottle-fed baby during the first six or eight months of life. For comparative purposes in the estimation of overweight and underweight in infants coming under observation, the following may be taken as working averages. For accuracy, a balance scale is necessary; the ordinary dial scale is unreliable.

The average weight at birth is 7 pounds (3,200 gm., or about 3,333 gm.).

The average initial loss is 10 ounces (300 gm.), or about one tenth of the body weight at birth.

The birth weight is regained usually by the fourteenth day.

The weight is doubled at the end of the fifth month, and trebled at the end of the first year.

The average weekly gain during the first five months should approximate 5 ounces (150 gm.); during the remainder of the first year, 4 ounces (120 gm.).

The yearly gain during the second year is 6 pounds (2,727 gm.).

The gain during the third year is 4½ pounds (2,000 gm.).

The gain from the fourth to the eighth year is 4 pounds annually (1,800 gm.).

The gain from the eighth to the eleventh year is 6 pounds annually (2,700 gm.).

It is not sufficient, however, to base the determination of the amount of food on the weight of the baby alone, since two infants of the same weight may have decidedly different nutritional requirements. The fat baby requires less food per pound than the thin baby, and the overfed less than the underfed infant; the sick baby must of necessity be fed within its limits of tolerance during the acute stage of its illness. The body losses must also be compensated for during convalescence, as the baby's tolerance for food permits, by increases in the diet beyond the normal feedings per pound of body weight.

Within certain limitations, therefore, a healthy infant should show a regular gain. It is not absolutely necessary that an infant add to its body weight every day, as daily irregularities are the rule rather than the exception. The relation of the time of weighing to feeding, defecation and urination must always be taken into consideration, and under normal conditions it is sufficient to *weigh the infant once a week*. It is especially wise to impress this on a nervous mother.

Further, we must not forget that the weight curve of the nursing infant and that of the artificially fed infant differ widely, so that they cannot be directly compared. Although in the beginning the artificially fed infant gains less than the breast fed, in the course of a year he reaches the same weight. The latter at first shows larger gains, but later lags somewhat. Much more important than the weight itself is that the successive weight figures shall form a rising series.

Caloric Needs.—Having determined the infant's weight and obtained a fairly definite idea as to its general physical condition, its caloric needs should be estimated so as to gain an idea of its total dietetic needs. The estimation must of necessity be based on its existent weight curve, duly considering its general con-

dition and its weight as compared with other infants of the same age. One should think not so much of providing a given number of heat units as of the food elements necessary to furnish those units. Each gram of fat in the diet will furnish 9.3 calories, and each gram of protein and carbohydrates, 4.1 calories.

Under this system the physician reckons the minimum daily caloric requirement, either from the present weight of the baby or what it should weigh in health, and then selects the food, so proportioning the fat, carbohydrate and protein content that it will not only meet the caloric requirements, but also will contain the proper amount in grams, of each of the constituents, to meet the infant's needs for growth and development.

In considering the caloric content, the part played by the various food components must be remembered. Benedict and Talbot [35] found that the basal requirements are highest per kilogram at about the ninth month, and steadily fall from this time up to adult life. Holt and Fales [36] estimated that the food value normally lost in the excreta is a nearly uniform proportion of the intake, about 10 per cent. for all ages after infancy, and that the requirements for growth are greatest during the first year of life, and during adolescence; also that the requirement for activity is the only factor which varies widely with different individuals. As the emaciated infant is expected to gain more rapidly in proportion to its body weight than the fat and well nourished infant, it will of necessity require a food with a higher energy quotient to maintain its growth ratio.

The sick baby will rarely be able to digest an amount covering its full needs, as estimated by its body weight. Therefore, as in every other phase of infant feeding,

35. Benedict, F. G.: Boston M. & S. J. **181**: 107 (July 31) 1919.
36. Holt, L. E., and Fales, H. L.: Food Requirements of Children: Total Caloric Requirements, Am. J. Dis. Child. **21**: 1 (Jan.) 1921.

individual consideration is necessary. It must be remembered that the nutrition of the baby depends on the quantity of food *assimilated,* and not on the quantity *ingested.* Less food is absorbed and utilized by the infant with deficient digestive power, and overfeeding will retard its progress. A comparative estimate of the infant's diet, with a theoretical minimum, is of special value in cases in which doubt exists as to whether the retarded progress is due to insufficient food or to defective digestion and assimilation.

TABLE 8.—*Caloric Needs*

Average infants under 2 months of age, from 30 to 45 calories per pound (from 65 to 100 per kilogram)
Average infants over 2 months of age, from 45 to 55 calories per pound (from 100 to 120 per kilogram)
Premature and thin infants under 2 months of age, from 50 to 65 calories per pound (from 110 to 140 per kilogram)
Thin infants older than 2 months, depending on their general condition, from 55 to 70 calories per pound (from 120 to 150 per kilogram)

Repeated clinical experience proves that the earlier figures of Heubner and Rubner are too low for the average infant on bottle feedings. They estimated that the average healthy infant requires on the average 100 calories per kilogram of body weight during the first six months of life, and from six months to the end of the first year approximately 85 calories per kilogram; and that 70 calories per kilogram of body weight is the energy quotient on which a baby can maintain a weight equilibrium. Instead of lessened caloric needs toward the end of the first years, his increasing activities demand heightening rather than lowering his food intake. Clinical observation in a large number of cases leads to the conclusion that, to assure satisfactory gain, the figures given in Table 8 must be approximated in the artificial feeding in infants.

During the first few weeks of life of the artificially fed infant it is usually difficult to approximate these figures.

Increases in the quantity of food should always be gradual, especially when malnutrition is present, and the infant must be carefully observed and increases made only as the food tolerance permits.

Estimation of the caloric content of the food *is not a feeding method,* and should be used only as a check on overfeeding and underfeeding, the scale, stools, general condition, and particularly the disposition of the infant being the ultimate guide for dietetic changes.

TABLE 9.—*Caloric Values of One Ounce (Thirty Grams) of Various Foods*

	Calories
Cow's milk	21
Human milk	21
Cream (16 per cent.)	54
Skim milk	11
Buttermilk	11
Buttermilk mixture	21
Albumin milk	12
Chymogen milk	21
Keller's malt soup	25
Cane sugar (by weight)	120
Maltose-dextrin compounds (average)	110
Malt-soup extract, dry, by weight	90
Malt-soup extract, dry, by volume	132
Corn syrup, by weight	80
Corn syrup, by volume	110
Flour, by weight	100
Cereal waters (1 ounce of cereal to the quart)	3

The *energy quotient* is the number of calories which the infant is getting per pound or per kilogram of body weight. To determine the energy quotient of the diet, the number of ounces of each food ingredient of the food mixture is multiplied by their caloric values, the products are added, and the sum is divided by the number of pounds or kilograms of the baby's weight.

CHAPTER XV

ESTIMATING THE AMOUNTS OF THE INDIVIDUAL FOOD ELEMENTS

Protein.—Holt and Fales [37] found in their investigations that the protein intake of the normal nursing infant is very low, ranging during the first nine months of life approximately from 8 to 12 gm. daily. This is equivalent to about 1.5 gm. per kilogram (0.7 gm. per pound). Up to the age of 8 or 9 months the protein taken by the nursing infant seldom exceeded 12 gm. daily. Our own observations indicate that most breast-fed infants will average a daily protein intake of 2 gm. per kilogram.

When cow's milk is substituted for human milk the protein intake is considerably increased—doubled or even at times trebled. Infants from 1 month to 9 months of age receive from 15 to 30 gm. of protein daily when fed on the usual modifications of cow's milk. This represents fully 3 gm. and often 4 gm. protein per kilogram (from 1.4 to 1.8 gm. per pound). The increase in protein requirement when cow's milk is substituted for mother's milk is probably due to the difference between the two milks in amino-acid content. Mother's milk contains about twice as much lactalbumin (1.23 per cent.) as does cow's milk (0.53 per cent.). The lactalbumin, which forms two thirds of the protein of mother's milk, contains the highest proportions of the amino-acids leucin, lysin and tryptophan, of all the protein bodies. The work of Osborne and Mendel,[38] as well as that of others, has shown that lactalbumin is especially efficient in promoting growth, while casein, which forms one third of

37. Holt, L. E., and Fales, H. L.: Food Requirements of Children: Protein Requirement, Am. J. Dis. Child. **22**: 371 (Oct.) 1921.

38. Osborne, T. B., and Mendel, L. B.: J. Biol. Chem. **25**: 1, 1916; ibid. **37**: 223, 1919

the protein of human milk (0.59 per cent.) and five sixths of the protein of cow's milk (3.02 per cent.) is of comparatively low grade as a growth protein. The chief demands for protein are for compensation for wear and tear and to provide for growth.

Holt and Fales found also that healthy children in their usual diet take about 4 gm. of protein per kilogram at the age of 1 year, the amount diminishing to about 2.5 gm. per kilogram at the age of 6 years. The young infant, as compared with the older child, requires proportionately a larger amount of protein to meet his needs for maintenance and growth. The total protein intake in the diet of infants and young children, per pound or kilogram of body weight, however, does not differ greatly in amount because the infant receives virtually all of his supply in the form of animal protein during his first year, the vegetable protein being represented by the small amount received in cereals and vegetables.

Vegetable proteins as a class are of distinctly lower grades than animal proteins. While they may be adequate for maintenance, it is hazardous with our present knowledge to depend on them for growth. Holt found that most of the children beyond the age of infancy took more than 60 per cent. of their total protein in the form of animal protein, from milk, eggs, meat, etc. The average was 66 per cent. of the total proteins from animal sources and 34 per cent. from vegetable sources. As vegetable protein cannot replace animal protein gram for gram, he believes that even if a larger proportion of vegetable protein than the usual one third of the total requirements is fed, the total protein intake must be considerably increased.

Sugars and starches, when added to a diet sufficient to meet any infant's need, will, temporarily at least, cause a greater nitrogen retention. Fats have little or

no influence. Nitrogen, to be retained, must be built up into living protoplasm, and to accomplish this salts must be available. Unless they are present, the nitrogen is again excreted. Approximately 1.7 gm. of ash are retained for each 1 gm. of nitrogen (Howland), or 0.3 gm. of ash for each 1 gm. of protein.

The healthy, normal infant may be fed a minimum of 1½ ounces of milk to a pound (100 c.c. per kilogram) of body weight, which would represent 1.5 gm. of protein per pound of body weight (3.5 gm. per kilogram).

Notwithstanding what has been said on theoretical and experimental studies of the protein needs of the artificially fed infant, as compared with the amount of protein received by the breast-fed infant, it must be granted that the proteins of cow's milk cover the protein needs of the infant, and that when in excess they rarely cause nutritional disturbances if the tendency to large curd formation is prevented by boiling or alkalizing the milk.

As a working minimum, the protein contained in 1½ ounces of milk per pound (100 c.c. per kilogram) of body weight of the normal infant may be used, and in the underfed this quantity may be increased to an amount equal to 2 or 2½ ounces per pound, thereby approximating 1½ ounces per pound of what the baby should weigh for his age. Increases of milk in the diet must be gradual, the additions being governed by the child's ability to handle the food. *From what has been stated, it may be inferred that it is wise to establish the protein content in a diet, which may then be supplemented by fats, carbohydrates and salts, because protein is the tissue builder and must necessarily be a basic constituent of all diets.*

Fats.—These are necessary to the normal growth and nutrition of the human body. But to a greater

extent than the other food elements, they can for a time be replaced by proteins and sugars, more especially the latter. This explains why infants fed on low fat mixtures, more especially proprietary foods, such as condensed milk, will continue to gain in weight. However, such development cannot be considered as normal, because the diet, besides being low in fat, rarely contains more than 1 per cent. of protein.

Fats furnish part of the heat energy necessary to maintain the body temperature. They are stored as a reserve food. The fat is a protein saver, and when supplied in proper amount but little protein is used for the production of animal heat, thus allowing the protein to be retained in greater amount for building the body tissues.

Fat is the carrier of the fat-soluble vitamins which are essential to normal growth, and in all probability have a direct relation to mineral metabolism. Fat also has a definite relation to calcium and probably magnesium metabolism independent of that due to its vitamin content. The best results in feeding are obtained when there is a definite relation between the fat and salt intake. Infants receiving an insufficient amount of fat in their diet show an increasing tendency to local and general infection, thereby giving evidence of lowered immunity.

Some infants digest fats badly, and when a fat intolerance is once established it is overcome only with great difficulty. In such cases it is necessary to throw on the carbohydrate the burden of furnishing the necessary extra food. Such a catastrophe should be avoided, as infants receiving an insufficient amount of fat rarely thrive satisfactorily. We should therefore aim to stay within safe limits. When the diet contains an insufficient quantity of fat, a high percentage carbohydrate feeding is usually instituted. This prevents the forma-

tion of soap stools, and tends to the development of diarrhea. For the formation of soap stools it is necessary that there be no excess of carbohydrate, and that there be present in the diet a relative excess of protein or fats or both. The resulting change in the chemical content of the bowel also has a decided influence on the bacterial flora in that the fat excreted in the intestinal tract combines with alkalis, which tend to overcome an excessively acid intestinal content.

Holt, in his studies, found that the nursing infant usually receives, during its first weeks, as much as 20 gm. of fat daily, and that the total increases by the seventh month up to an average of 40 gm. daily, the latter representing about 4 gm. per kilogram (1.8 gm. per pound) of body weight. Each gram of fat has an energy value of 9.3 calories, while protein and carbohydrate each furnishes 4.1 calories per gram; therefore, each gram of fat provides for more than twice as many calories. The tendency toward normal growth and development on the part of a nursing infant on a high fat feeding illustrates the value of this element in the diet.

Our clinical experience has demonstrated that while the tolerance for the fat of cow's milk varies greatly in different individuals, most infants will digest and assimilate 1.8 of fat per pound of body weight daily. This is the quantity contained in 1½ ounces of average cow's milk of good quality (4 gm. per kilogram, the amount contained in 100 c.c.). This quantity will also supply the body needs for growth and development when associated with sufficient protein and carbohydrate.

Carbohydrates.—These are used chiefly to supply heat and energy, to supply in part material for fat foundation, thereby partly replacing the fat waste. Because of their high caloric value, they supply a large

amount of energy. They are efficient sparers of protein, and will supply energy in case of fat insufficiency in the diet. Synthetically, they are converted into glycogen in the body. Fat is formed from sugar by the subcutaneous cells, which are especially adapted to this function.

Normally, in greater part, sugar is absorbed from the small intestine and is not found in the feces. If absorbed in sufficient quantity it will cause a rapid increase in weight. When insufficient carbohydrate is supplied to the body, it supplies the deficiency by breaking down the body protein.

The majority of infants have a high carbohydrate tolerance, and the same is true of most infants suffering from nutritional disturbances. Exceptions to this are seen in some of the fermentative diarrheas, some eczemas, and exceptionally in a few other conditions. Fortunately, the ability to metabolize carbohydrates is often present even though fats and proteins are poorly digested.

For practical purposes, the carbohydrates used in infant feeding may be divided into three large groups: (1) the disaccharids, of which saccharose (cane sugar), lactose (milk sugar) and maltose are the best examples; (2) the polysaccharids, of which the cereals, flours and dextrin are most commonly used, and (3) mixtures of the disaccharids and polysaccharids, combinations of which are contained in most of the proprietary infant foods.

Cane and Milk Sugars.—As regards the relative nutritive value of cane sugar and milk sugar, there is little to recommend one over the other so far as their food value and the limit of tolerance are concerned. When large quantities of lactose are fed, a laxative effect is more frequently seen than with cane sugar feeding of simillar quantities by weight. Cane sugar

is heavier than lactose; two tablespoonfuls of the former and three of the latter approximate 1 ounce by weight. *Cane sugar will answer the needs of most infants.* This assertion is based on a large experience with infant-welfare patients among whom economy, of necessity, had to be considered.

The total carbohydrates (sugar contained in the milk, sugar added to the milk, and cereal, if used), should average from one-eighth to one-fifth ounce (4 to 6 gm.) per pound (from 9 to 13 per kilogram) of body weight a day. One and one-half ounces of milk, averaging 4.5 per cent. carbohydrate, furnishes 2 gm. of lactose. Normal full-weight infants will usually require a minimum addition of one-tenth ounce (3 gm.) by weight of sugar to the milk mixtures for each pound of body weight (6.6 gm. per kilogram). For underweight infants the amount should at first be calculated on the basis of their present weight, but increased if well taken, to meet the amounts indicated for a full-weight infant of similar age.

Carbohydrates needed beyond that furnished by 1½ ounces of sugar should be supplied by well cooked cereals or cereal waters, because of the danger of fermentative diarrhea. (See mixed feeding.)

Holt and Fales,[39] in their investigations on nursing infants, found that they took, on the average, about 12 gm. of carbohydrate per kilogram of body weight daily. Artificially fed infants usually received somewhat more than this. They believe that an infant of average activity should at one year be allowed about 12 gm. of carbohydrate per kilogram of body weight, the amount being decreased to about 10 gm. per kilogram at 6 years, and maintained at this value throughout the remainder of the growth period.

39. Holt, L. E., and Fales, H. L.: The Food Requirements of Children: Carbohydrate Requirement, Am. J. Dis. Child. **24**: 44 (July) 1922.

The sugar content of the food of infants who have been on a low sugar diet should be gradually increased in order that they may become accustomed to the altered amounts.

In changing from one kind of sugar to another, it is always safe to reduce the quantity for a few days, further increases being governed by the infant's tolerance. Partially replacing of the disaccharids by cereal waters and gruels usually results in the amelioration of digestive disturbances following the use of excessive amounts of sugars. Clinical observations have led to the belief that both sugar and well cooked starches, after the second month, have distinct advantages in the diet.

Maltose and Dextrin Compounds.—These have little to recommend them in the feeding of most infants. They can usually be administered in somewhat larger quantities: one-eighth ounce (4 gm.) for every pound of normal weight. However, it is to be remembered that similar amounts of carbohydrates can be given by feeding cereals with sugars. In using maltose and dextrin compounds it is to be remembered that their action on the bowels varies greatly, depending on their maltose, dextrin and alkali content. Thus, we find that proprietary foods containing a considerable percentage of dextrin, in the absence of added potassium salts, are constipating, while those with a high maltose content, more especially when containing potassium carbonate or bicarbonate, are laxative in their effect.

Cereals.—Cereals in water or gruels may be added to the milk mixtures in quantities varying from one-sixtieth to one-thirtieth ounce (0.5 to 1.0 gm.) for each pound of body weight, daily (1.0 to 2.0 gm. per kilogram). Cereal waters may be used as a diluent as early as the second month of life, and the cereal gruels by the fourth month. The addition

of a second carbohydrate to the infant's diet is frequently followed by increases in the weight curve out of proportion to the food value of the cereals. This is especially true when the whole grain rather than the dextrinized flours is used in the preparation. It cannot be stated whether this is due to vitamins or vegetable proteins contained in the preparations made from the whole grain. The cereals also have a decided influence on the calcium and magnesium balance, owing, in all probability, to the same factors.

Salts.—Human milk contains 0.2 gm. of ash in 100 c.c., and cow's milk 0.75 gm. of ash in 100 c.c. The difference in percentage in human and cow's milk is

TABLE 10.—*Grams of Salts in 1,000 c.c. of Milk*

	CaO	MgO	P_2O_5	Na_2O	K_2O	Cl	Fe
Human milk...	0.458	0.074	0.345	0.132	0.609	0.358	0.0017
Cow's milk....	1.72	0.2	2.437	0.465	1.885	0.822	0.0007

equalized by the body's using only what is necessary for its life and growth. The salts are absolutely necessary for the life of the organism.

Holt, Fales and Courtney, in their studies on calcium metabolism, concluded that:

> The total absorption of calcium oxid varied in general with the weight of the child. . . . An excessive calcium intake apparently did not increase the calcium absorption, the excess being excreted.
>
> The average absorption of calcium oxid by healthy infants taking modifications of cow's milk was 0.09 gm. per kilogram of body weight. Since the average absorption of calcium oxid by breast-fed infants was 0.06 gm. per kilogram, it may be assumed that 0.06 gm. per kilogram is the minimum normal absorption by infants taking modifications of cow's milk.
>
> To insure the average absorption of 0.09 gm. of calcium oxid per kilogram, the intake of calcium oxid should be at least 0.19 gm. per kilogram with cow's milk feeding; to

insure an absorption equal to the average found for breast-fed infants, the intake of calcium oxid should be at least 0.13 gm. per kilogram.

The best absorption of calcium was obtained when the calcium intake bore a definite relation to the fat intake, that is, when the food contained from 0.045 to 0.060 gm. of calcium oxid for every gram of fat, and when at the same time the fat intake was ample, not less than 4 gm. per kilogram.

An infant receiving one tenth of its body weight in milk, that is, 100 gm. per kilogram (one and one-half ounces per pound) of body weight will have an intake of 0.17 gm. of calcium oxid per kilogram (0.08 gm. per pound). At the same time, the infant will have an intake of 4 gm. of fat per kilogram (1.8 gm. per pound).

The percentage content of magnesium, sodium and potassium salts is approximately the same in human and in cow's milk; but quantitatively, in cow's milk, it is about three times as great. Therefore, in mixtures containing the recommended amount of cow's milk there will be about 50 per cent. more of these salts than in the average quantity of breast milk taken by an infant.

Of the inorganic constituents, phosphorus ranks among the most important. Human milk contains 0.345 and cow's milk 2.437 gm. of phosphorus pentoxid per liter, a ratio of about 1 to 8. Of this, approximately 43 per cent. in human milk and 46 per cent. in cow's milk exists as organic compounds. Various authors find that from 53 to 80 per cent. of the phosphorus in cow's milk, and from 65 to 90 per cent. in human milk, is absorbed. If these figures are correct, we may be assured that there is at least sufficient phosphorus in cow's milk mixtures to provide for the infant's needs. Therefore, a question of more importance is the ability of the infant to fix in its body tissues the phosphorus which it receives in its diet.

Theoretically, at least, the iron content in breast as well as cow's milk is insufficient to meet the infant's requirements, and in both instances it must draw to some extent at least on its iron deposits. In artificial feeding it is especially important during the first six months that provision be made for supplementing from other sources the iron contained in the cow's milk.

Salts are necessary for building the body tissue, and each gram of protein retained and built into the body tissue requires approximately one-third gram of ash.

The average infant receiving cow's milk, with its greater salt content, lives on a higher plane of mineral metabolism than one receiving breast milk. In the majority of infants, this excessive salt intake undoubtedly does no harm; the surplus is not absorbed, and is merely eliminated.

Sodium and potassium are usually well retained, unless severe diarrhea is present or there is an excess of fat or of sugar in the diet. Under such circumstances the salts are lost, and the loss is badly borne and cannot indefinitely be continued. When all available alkalis have been drawn on, the infant breaks down its own tissue to furnish more of these substances, which explains, in part at least, the excessive nitrogen excretion in such cases. When diarrhea ceases and the intake is sufficient, a positive balance is rapidly instituted.

CHAPTER XVI

SUMMARY OF QUANTITATIVE AND CALORIC RELATIONSHIP OF THE FOOD CONSTITUENTS

In the diet recommended as a *minimum* for the average normal infant on a diet of cow's milk with added carbohydrates, namely; per pound, milk 1½ ounces, sugar 1/10 ounce and starch 1/60 ounce, or per kilogram, milk 100 c.c., sugar 6.6 gm. and starch 1.1 gm., the distribution of ingredients would be as in Table 11.

TABLE 11.—*Ingredients in Minimal Diet*

	Proportion of Amounts			Distribution of Calories		
	Per Pound Grams	Per Kilogram Grams	Per Cent.	Per Pound	Per Kilogram	Per Cent.
Fat	1.8	4.0	20.5	16.74	37.2	37
Protein	1.5	3.5	17	6.15	14.35	14
Sugar { in milk	2.0	4.5				
Sugar { added	3.0	6.6	62.5	22.55	49.61	49
Starch	0.5	1.1				
Calcium oxid	0.08	0.176				
			Total	45.44	101.16	

The ratio of the amounts of the components of the diet, when expressed in percentages, shows: fat, 20.5; protein, 17; carbohydrate, 62.5; that of the caloric distribution of the ingredients is: fat, 37; protein, 13.5; carbohydrate, 49.5.

The *amount* of fat in the diet, therefore, slightly exceeds the protein, while the carbohydrate is somewhat more than three times the fat or protein.

The *caloric value* of the diet, however, shows that the fats are about two and one-half times the protein, while the combined fat and protein calories about equal the carbohydrates.

Holt,[40] in studying the diets of a series of 106 children, ranging in ages from 1 to 18 years, found that

40. Holt, L. E.: Food, Health and Growth, New York, the MacMillan Company, 1922.

the average percentage distribution of the food intake in calories was: fat, 35; protein, 15; carbohydrate, 50.

The combined calories of food elements usually recommended for the normal infant average 45 for each pound, or 100 calories for each kilogram body weight. Clinical experience leads me to recommend this amount as the *minimum required* by the average artificially fed infant of the second month (see caloric needs). The greater needs of the individual infant for growth are to be met by increasing the total food given or such of the ingredients as may be indicated. Only under exceptional circumstances should the suggested

TABLE 12.—*Calories in Fat, Protein and Carbohydrates*

Fat	1 gram	= 9.3 calories
Protein	1 gram	= 4.1 calories
Carbohydrate	1 gram	= 4.1 calories

proportions be deviated from to any considerable amount, and then only through the reparation stage if normal development is to be expected.

NUMBER OF FEEDINGS IN TWENTY-FOUR HOURS

Four-Hour Intervals.—It has been proved that the usual cow's milk mixtures fed to infants do not leave the stomach completely for at least three hours after ingestion. Most normal infants will be satisfied when placed on suitable mixtures at four-hour intervals. For several years, normal infants have been fed successfully on four-hour periods. The most suitable hours are 6 and 10 a. m., and 2, 6 and 10 p. m., with a 2 a. m. feeding if necessary. Most infants will be satisfied with five feedings daily from birth.

Three-Hour Intervals.—If the three-hour interval is indicated, one should begin with seven feedings in twenty-four hours for the first month (6, 9, 12, 3, 6, 10, 2); six feedings during the second and third months

(6, 9, 12, 3, 6, 10), and five feedings by the fourth to the fifth month (6, 10, 2, 6, 10), according to the individual need.

Premature and delicate infants having a tendency to vomit, as such cases are exceptions, may be fed smaller amounts more frequently, even at two-hour intervals, if indicated. In case catheter feeding is necessary, the longer interval will usually suffice.

Water to Be Added.—It is most important to remember that young infants require a minimum of one fifth of their body weight of fluids daily (3 ounces per pound), and in their later months at least one sixth of their body weight (2½ ounces per pound) daily.

For the average normal infant, the *amount of water to be added* to the mixture is calculated by estimating that young infants, after their first few weeks of life, should be given 3 ounces of fluid daily per pound (200 c.c. per kilogram) of body weight, and older infants 2½ ounces. The difference between the total fluids required by the infant for a day's feeding, and the amount of milk fed, equals the amount of water to be added. The food mixture is divided into equal portions, the number of which will vary with the feeding interval. Infants having a tendency to vomit usually have to be limited to 2½ ounces of fluid per pound of body weight.

Underweight infants will require a total of fluids approximately 3 ounces, or at times even more per pound of body weight. Very fat infants will often be satisfied with somewhat less water than suggested.

After the fourth month, the average infant will take at least one quart of the food mixture daily. By this time a mixed diet may be instituted by adding a well cooked cereal to one or two of the day's feedings.

After the sixth month, four meals of 8 ounces each of a milk mixture may be given, and a fifth meal of a

vegetable broth may be added. *Mixed feeding will be discussed more fully under Additional Foods.*

It has been found that a concentrated milk mixture does not disturb the infant's digestion when the milk is boiled, when cereal waters are used as diluents, or when it is alkalized by the addition of sodium citrate or lime water.

Carbohydrates to Be Added.—Having the necessary amount of milk and water, we ascertain the amount of carbohydrates to be added. Cane or milk sugar will satisfy the needs of the average normal infant during its first month when added in amounts of one-tenth ounce (3 gm.) per pound. Somewhat more than twice this quantity (6.6 gm.) should be added per kilogram of body weight to the day's mixture. Cane sugar mixtures are occasionally refused by infants when large amounts are added because they are too sweet. In such cases, part of the sugar can be replaced by milk sugar or maltose-dextrin compounds.

After the infant is 1 or 2 months old, from one-sixtieth to one-thirtieth ounce (0.5 to 1 gm.) of cereal or cereal flour for each pound of body weight may be added to the mixture. This is best given as cereal water. The addition of the second carbohydrate often has a very beneficial effect on the weight curve.

In underweight infants, the amount of sugar to begin with should be calculated on the basis of the existent weight, approximating the quantity needed for a full-weight infant as rapidly as the sugar tolerance permits.

Table 13 gives equivalents of 1 ounce by weight and the domestic measures of carbohydrates used in the artificial feeding of infants.

To Break the Curd to Assist Digestion of Cow's Milk.—Many infants can digest raw cow's milk.

When it is not well digested, the formation of large protein curds is obviated by boiling the milk from two to three minutes over the flame or, better, by putting it in a double boiler and heating it until the water in the outer vessel boils eight minutes. Although the curd is less finely divided by the use of the double boiler as compared with boiling over the direct flame, it answers the purpose for most infants and causes fewer changes in the milk. A small double boiler should be used, as in it the column of milk is deep and has a small surface. The milk should simmer

TABLE 13.—*Equivalents of an Ounce*

	By Weight		By Measure	Spoonfuls, Leveled with Knife		
	Ounce	Gm.	Ounces	Table	Dessert	Tea
Cane sugar	1	30	1.00	2	3	6
Milk sugar	1	30	1.50	3	4.5	9
Maltose-dextrin	1	30	1.50	3	4.5	9
Flour (wheat)	1	30	2.25	5	7.5	15
Flour (barley)	1	30	1.50	3	4.5	9
Barley (pearl)	1	30	2.50	5	8	15
Oats (rolled)	1	30	2.50	5	8	15

1 tablespoonful = 1.5 dessertspoonfuls = 3 teaspoonfuls

rather than boil actively, and in the larger vessel boiling takes place more readily. Milk that has been simmered undergoes less change in taste than that which has been actively boiled and there is less loss of soluble protein, fat, sugar and salts.

The feeding of raw diluted cow's milk has certain unquestionable advantages; however, when its source is in any way doubtful or its subsequent handling is likely to have led to contamination, it should be either pasteurized or boiled.

Cereal water diluents cause the formation of fragile curds. Addition of sodium citrate to the milk mixtures also prevents the formation of hard protein curds. Sodium citrate may be prescribed either in 5-grain tablets, approximately one-half to 1 grain being added

for each ounce of the milk mixture, or a prescription may be so written that each teaspoonful of the prescribed formula will contain sufficient sodium citrate for the day's food.

When lime water is added to cow's milk until it is neutral or faintly alkaline to phenolphthalein, a basic calcium casein is formed which is not acted on by rennet and will not form a curd, even in the presence of lime salts (Van Slyke). Lime water is commonly used in amounts equaling 5 per cent. of the milk in the mixture (1 ounce to 20 ounces of milk). In most instances no advantage is gained by adding alkalis to boiled milk mixtures. Occasionally the addition of sodium citrate or lime water to boiled milk will be found of advantage in cases of difficult feeding and in the presence of vomiting.

Fig. 8.—Utensils needed for artificial feeding: fine sieve; double boiler (small); bottle brush; feeding bottle; bottle rack; paper caps; nipples; nipple jar; funnel; glass graduate; milk, 1 quart; water (boiled); cereal; sugar; tablespoon; dairy thermometer.

CHAPTER XVII

PRINCIPLES GOVERNING THE PREPARATION OF MILK MIXTURES

So far as it has been developed by the scientific knowledge of the present day, the basis to be recommended for the artificial feeding of average normal infants is the unit requirements in fat, protein, carbohydrate, salts, water and accessory food factors per pound or kilogram of body weight.

It is therefore evident that there must be a rational understanding of the infant's digestive and metabolic processes as concerns the individual ingredients of his diet, and that the quantitative relationship of the individual components of the diet to these physiologic processes must be duly considered. It soon becomes evident that while in many instances one or more of the food elements may cause digestive disturbance, poorly balanced combinations of these elements have a far greater influence on its development. If all the ingredients are in excess, it may cause a general upset to develop rapidly; but the insufficiency of one or more of the ingredients usually results in the more chronic type of nutritional disturbances. One of the best illustrations of the latter type is seen when proper quantities of fat and protein are fed but the carbohydrates are insufficient. A similar but less constant picture presents itself when fat is insufficient in an otherwise well balanced diet.

It is therefore necessary to consider, first, the fundamental principles governing nutrition, basing these on knowledge not only of the digestion, absorption and later metabolism of the individual food elements, but also of their relative action. It must also be remembered that an improperly constituted

diet reacts on both the quantity and quality of the digestive secretions, affords pathogenic bacterial flora a suitable medium in which to develop, and accelerates or delays the intestinal reaction, having thus a direct effect on the infant's development.

While the chemical composition of the diet must be most carefully considered, its quality, as regards its freshness and purity, is equally important. Therefore, in providing a suitable food, its source, subsequent handling and finally its proper modification must be supervised. A study of the literature arising during the last half century, concerning the many theories and methods advanced for the feeding of infants, emphasizes that *no substitute has been found for human milk.*

When an infant is fed on food not primarily intended for its use, attempts at adaptation must be made, and their number as mentioned in the literature shows conclusively that no single method can possibly meet all demands.

Realizing that rigid dogmatism will ultimately lead to confusion, it is our object here to formulate principles of feeding which are adaptable to the majority of well babies and will allow for their physiologic development. The discussion of the feeding of sick infants will be considered later. Such principles, to be worthy of recommendation, must permit of elasticity in the administration of individual ingredients and must be based on our present knowledge of the needs of the body for growth and development. *It is to be remembered that the diets to be recommended, although meeting the requirements of most infants, will be excessive for some and inadequate for others. Infants differ in their use of the food administered.*

In formulating a scientific basis for infant feeding, we must recognize that at present no hard and fast

rules can be laid down for clinical application. Our present methods are still more or less empiric, and the result is dependent to a considerable degree on the wide range of food tolerance of the healthy infant. Hence in order to insure success the physician must depend on his own clinical observations.

The needs of the normal breast-fed infant are well known. The breast-fed infant taking 2½ ounces of milk per pound of body weight receives fat, 2.6, protein, 1.1, and carbohydrate, 5 gm., daily for each pound of weight. So long as he receives daily 2½ ounces of breast milk per pound of his body weight, it matters little to him whether he is given frequent feedings of small amounts or the more desirable larger individual feedings at longer intervals.

It should be emphasized that the needs of the artificially fed infant for the various food elements must be interpreted on the same basis of unit requirements per pound or kilogram of body weight. If the adoption of this method were to secure no other result than to cause a collection of facts from the various clinics for comparative study, it will have served a good purpose.

In the past, percentages of the food elements in their relation to the total milk mixture have been used, orders being written for two-thirds milk mixture, plus 5 per cent. carbohydrate, or a mixture containing fat, 2 per cent., protein, 1 per cent., and carbohydrates, 6 per cent., etc. This, more than any other method, has led to the many so-called schools of infant feeding and possible misinterpretation of end-results. In our present consideration of the infant's food requirements, his needs in fat, protein, carbohydrates, salts and water will be discussed with regard to each pound or kilogram of body weight, secondary emphasis being

given to the percentages in the mixture. The German schools of pediatrics were the first to emphasize the caloric requirements of the infant and to make use of these as a basis for calculating food supply. This led in many instances to unbalanced diets, because heat units were thought of rather than food elements. The caloric content of the diet will be considered, therefore, chiefly as constituting a check on overfeeding and underfeeding as a whole and not as a basis for constructing diets.

The question presenting itself to the practitioner is this: Can this principle be practically applied in every-day infant feeding?

Every formula with which feeding is begun should be looked on as experimental, and the reaction of the infant to this feeding should be carefully studied.

If these principles are borne in mind, many an obstacle to successful infant feeding will be overcome.

The attempts toward ultrarefinement of the infant's diet have led to considerable confusion because of the different conclusions of the various schools. Eventually infant feeding will be placed on a thoroughly scientific basis. This, however, does not answer the present-day needs, *which call for a safe and practical solution of the feeding problem for the every-day baby in every-day life.* Feeding advice commonly comes from food manufacturers, and if one preparation is not successful a rapid transition is made from one proprietary baby food to another, with untold detriment to the infant. In clinical experience, the rules advocated for feeding the normal healthy infant *on simple milk mixtures with carbohydrates added,* with further suggestions for the underfed, have been found safe for the baby and practical for the physician, which latter is to be neither overlooked nor taken lightly.

DATA AS TO FOOD AND FOOD REQUIREMENTS USED AS A BASIS FOR ESTIMATING THE DIET OF INFANTS

Average cow's milk contains the percentages given in Table 14.

The grams of food elements needed as a minimum in twenty-four hours by the average normal artificially fed infant are given in Table 15. The milk or cream

TABLE 14.—*Content of Cow's Milk*

	Per Cent.
Fat	4.0
Protein	3.5
Carbohydrates	4.5
Calcium oxid	0.172

TABLE 15.—*Grams of Food Elements Needed as a Minimum in Twenty-Four Hours by the Average Normal Artificially Fed Infant*

	Per Pound	Per Kilogram
Fat	1.8	4.0
Protein	1.5	3.5
Carbohydrates	5.0	11.0
Calcium oxid	0.08	0.17
Water	90.0	200.0

TABLE 16.—*Ingredients to Be Added for Each Gram of Food Elements*

Fat	$\frac{2}{10}$ oz., or 6 c.c., of cream $\frac{5}{6}$ oz., or 25 c.c., of milk
Protein	1 oz., or 30 c.c., of milk or skim milk
Carbohydrates	$\frac{1}{30}$ oz., or 1 gm., of sugar
Calcium oxid	18.5 oz., or 600 c.c., of milk or skim milk

and skim milk needed to supply fat and protein will average 2 gm. of sugar. It will therefore be necessary to add the amount needed in excess of this, one-tenth ounce (3 gm.) per pound, or 6.6 gm. per kilogram.

For each gram of food elements in the mixture, the ingredients listed in Table 16 must be added.

TABLE 17.—*Requirements for Each Pound of Body Weight*

Fat (1.8 gm.)	1½ oz., or 45 c.c., of milk
Protein (1.5 gm.)	1½ oz., or 45 c.c., of milk or skim milk
Carbohydrates (3.09 gm.)	1/10 oz., or 3 gm., of sugar
Calcium oxid (0.08 gm.)	1½ oz., or 45 c.c., of milk or skim milk

TABLE 18.—*Requirements for Each Kilogram of Body Weight* *

Fat (4.0 gm.)	25 c.c. of cream; 100 c.c. of milk
Protein (3.5 gm.)	100 c.c. (of milk or skim milk)
Carbohydrates (6.6 gm.)	6.6 gm. of sugar
Calcium oxid (0.172)	100 c.c.

* No allowance made for protein in cream. Protein figured at 3.5 per cent. in milk.

WHOLE MILK DILUTIONS WITH CARBOHYDRATE ADDITIONS

In applying the rules for the feeding of normal, healthy infants it must be remembered, as previously emphasized, that each infant must be fed to meet its individual requirements. Therefore the rules must be so modified as to meet the individual demands. If milk dilutions with the addition of carbohydrates are used, the simplest and most natural standard is that which tells us how much milk and carbohydrates the baby should get per pound or per kilogram of body weight.

To be exact, we should express, or at least be aware of, the number of grams of proteins, fat, carbohydrates, salts and water that the infant is receiving for each pound of its body weight.

If statistics on infant feeding were collected on this basis rather than on percentages of the ingredients in the milk mixtures (the total mixtures used by different physicians being of such variable quantity), the collected data would be far more valuable as a basis for future work in infant feeding.

In every instance the general health of the infant is of the greatest importance in estimating its capacity for assimilating the diet.

To meet the minimal per pound body weight protein (1.5 gm.), fat (1.8 gm.), and calcium oxid (0.08 gm.) requirements, the average normal infant will require each day a minimum of 1½ ounces (45 c.c.) of cow's milk. For each kilogram of body weight, 3.5 gm. of protein and 4.0 gm. of fat will be required. These will be furnished by 100 c.c. of cow's milk.

For normal full weight infants, the addition of one-tenth ounce (3 gm.) by weight of sugar to the milk mixtures will be required for each pound of body weight (6.6 gm. per kilogram).

Water equal to 3 ounces per pound, or one-fifth the body weight, will meet the day's requirements for young infants, and amounts approximating 2½ ounces per pound, or one-sixth the body weight, will answer for older infants. The difference between the total day's fluid requirement and the milk in the mixture can be added as boiled water or cereal water or a portion of it may be fed between meals.

Cereals in the form of thin gruels may be added to the milk mixtures in quantities varying from one-sixtieth to one-thirtieth ounce (0.5 to 1 gm.) for each pound of the body weight after the first or second month of life.

A mixture formulated to include these recommended amounts of food ingredients will average about 45 calories for each pound of body weight (Table 19).

Practical clinical experience has taught us that infants fed on cow's milk mixtures will frequently require approximately 2 ounces (60 c.c.) of cow's milk per pound of body weight, except during the first few weeks of life, when smaller quantities of whole or skim milk are indicated. Such mixtures will average approximately 55 calories for each pound of body weight.

In beginning feeding with cow's milk, mixtures must always be started as weak formulas, more often only 1 ounce (30 c.c.) of cow's milk being used to a pound of body weight, the strength being gradually increased to meet the infant's needs.

Underweight infants should be fed according to their weight at the initiation of feeding, the strength of the mixture being increased gradually but rapidly as the baby shows ability to handle the food, thus approximating the needs of a full-weight baby of the same age, in milk, sugar and water. These babies will frequently, therefore, require 2 ounces (60. c.c.) or more of milk per pound of body weight, and carbohydrates must be added in proportion.

TABLE 19.—*Mixture Containing Recommended Amounts of Food Ingredients*

Milk, 1½ ounces	=	30 calories
Sugar, ⅒ ounce	=	12 calories
Starch, 1/30 ounce	=	3 calories
		45

With the institution of a mixed diet, the infant thrives with less milk per pound of body weight.

In preparing to feed an infant these general rules should be followed:

The baby should be weighed, and one should determine whether or not its weight is within normal limits.

The amount of cow's milk necessary in the preparation of the mixture should be determined. One and a half ounces of cow's milk per pound of normal body weight at the baby's age is a safe minimum for a healthy infant. It should be remembered that normal infants may require as much as 2 ounces per pound of body weight.

The total daily quantity of water required should be determined, 3 ounces per pound (one-fifth the body weight) during the first six months and somewhat less, 2½ ounces per pound (one-sixth the body weight) after this period. Suffi-

cient water (or cereal water) should be added to the milk to bring the total quantity of mixture up to the day's requirements in fluids.

Three grams of sugar, and later an additional 0.5 to 1 gram of starch should be added for each pound of body weight.

The curd should be made more digestible either by boiling, adding cereal water, or alkalizing the mixture.

MIXTURES ESTIMATED ON THE BASIS OF CALORIC REQUIREMENTS

The caloric needs of infants can be made the basis for formulating the constituents of their diet.

The protein, fat, salts and carbohydrates must be so combined as to meet the infant's needs in each of these elements.

Forty-five calories per pound, or 100 per kilogram, may be considered as meeting the minimal daily requirement of the average normal infant. Thin infants will require from 50 to 70 calories per pound (110 to 150 per kilogram).

The protein content should be supplied first; next the needs in fat, and last the carbohydrates.

Protein.—The normal infant will require a *minimum* of 1.5 gm., which provides 6 calories per pound; this is furnished by the protein contained in 1½ ounces of cow's milk. Per kilogram, 3.5 gm. provide 14.3 calories, furnished by 100 c.c. of milk.

Fat.—The needs in fat, 1.8 gm., or 16.5 calories, per pound, will, for most infants, be provided for by 1½ ounces of milk. Per kilogram, 4 gm., which provides 37.2 calories, will be furnished by 100 c.c. of milk.

Carbohydrates.—The sugar required in excess of the 2 gm. (8.2 calories) provided by the milk, when 1½ ounces is fed per pound, will amount to 3 gm., or one-tenth ounce, for each pound of body weight. This

will furnish 12.3 calories, or a total of 20.5 calories inclusive of the sugar in the milk. Per kilogram, 6.6 gm. of sugar must be added to the 4.5 gm. that is contained in 100 c.c. of milk. The infant will therefore receive 11 gm. of sugar per kilogram, which provides 45.5 calories. Therefore, in feeding 1½ ounces of milk, plus one-tenth ounce of sugar, the following calories will be provided: protein, 6; fat, 16.5, and sugar, 20.5, or a total of approximately 43 calories for each pound of body weight. This requires considerable calculation in estimating the proper proportion of the ingredients and even more so if a second carbohydrate as starch is added.

TABLE 20.—*Amounts Required for an Infant Weighing Ten Pounds*

	Ounces	Calories
Milk	15	315
Sugar	1⅛	135
Water	15	...
Total		450

TABLE 21.—*Amounts Required for an Infant Weighing Five Kilograms*

	Gm. or C.c.	Calories
Milk	500	350
Sugar	37.5	150
Water	500	...
Total		500

In feeding 100 c.c. of milk [41] with 6.6 gm. of sugar added, the infant will receive, for each kilogram: protein, 14.3 calories; fat, 37.2, and carbohydrates, 45.5, a total of 97 calories. We will therefore make use of the enumerated facts for calculating the initial diet

41. Milk calculated as containing percentages as follows: protein, 3.5; fat, 4; sugar, 4.5.

of a normal infant as follows: An infant weighing 10 pounds will require 15 ounces of milk. Calculating his caloric needs at 45 per pound, his diet should contain a total of 450 calories. Of this 315 calories will be furnished by his milk. The remaining 135 are to be supplied by carbohydrates, sugar or sugar and starch. If sugar is used, 1⅛ ounces will be required. Estimating 3 ounces of total fluids per pound of body weight, 15 ounces of water will be added as a diluent. The total formula will therefore be constituted as in Table 20.

If estimated by the metric system, an infant weighing 5 kg. requires 500 calories, and should receive the amounts given in Table 21.

While in the case of average normal full-weight infants this method of calculating the diet works out satisfactorily, when underweight infants are to be fed, the estimation of needed ingredients is less simple. It becomes even more complicated when cereals and other foods are added to the diet.

This method is also more complicated than the one previously recommended for analyzing diets that infants are taking. In comparing the two methods of estimating the needed ingredients for the infant's diet, the first is based on the amounts of each of the ingredients needed, and the second on the calories required.

It is to be remembered that the quantities recommended under the heading Milk Dilutions with Added Carbohydrates, in the amounts suggested as minimums, furnish approximately 45 calories per pound, or 100 per kilogram, of body weight—the proportions needed by the infant. In the feeding of underweight infants, the amounts ultimately needed are calculated on the basis of the estimated weight of the normal infant of the same age and development.

UNDILUTED WHOLE MILK WITH CARBOHYDRATES

While undiluted milk has been used with varying degrees of success by some of the continental pediatricians, on the whole it is not well borne before the fourth month of life. When undiluted whole milk is to be fed to a young infant, it should first be boiled in order to change the protein so that it will be precipitated in the infant's stomach as a fine curd. Alkalizing the milk by the addition of sodium citrate or sodium bicarbonate also results in the formation of fine curds. If undiluted milk is used in the feeding of the very young infant, the size of the individual meal must of necessity be reduced under that recommended for diluted mixtures, or fewer meals must be given. Otherwise the caloric requirements of the infant will be exceeded. Water must be administered between feedings to meet the infant's needs for fluids.

While, as a routine measure of feeding, undiluted whole milk cannot be recommended, in some forms of vomiting and when gastric dilatation is present, small quantities of a concentrated food can often be fed to better advantage than larger quantities of milk dilutions. When carbohydrates are added, they should be in such amounts as are indicated by the infant's weight and age.

TOP-MILK DILUTIONS

By this method a definite number of ounces of the upper part of milk which has stood for a number of hours is used as a basis for preparing the mixture.

To carry out top-milk feeding successfully, the percentages of fat must be known which occur at various levels in 32 ounces (1 quart) of milk (containing 4 per cent. of fat) which has stood for six hours or longer.

This method endeavors to provide ample calories, and in this respect may be considered as successful.

Fig. 9.—Tablespoonfuls: A, level; B, round; C, heaping.

The chief advantages are that high fat and low casein mixtures can easily be prepared by the use of various dilutions of different layers of top-milk. With these mixtures there is the danger of feeding dilutions containing an excess of fat, not uncommonly reaching 5 or 6 per cent. when the upper layers are used. Such high fat mixtures not uncommonly result in fat indigestion. The early advocates of this method recommended it on the basis of the low protein content of the mixture, believing that a high casein content frequently caused acute intestinal disturbances. In the light of our present knowledge, however, we know that the casein of milk boiled or alkalized, or mechanically divided by the addition of cereals, is easily digested and

TABLE 22.—*Fat Percentages*

	Per Cent.
Upper 16 ounces	7
Upper 20 ounces	6
Upper 24 ounces	5

causes nutritional disturbances only in exceptional cases. Owing to the tendency to use high dilutions, the sugar and salt content, more especially the latter, may be insufficient. This method of feeding has many advocates, and has given good results when its shortcomings are recognized and the diets properly balanced.

It will be of advantage to use the upper 16 ounces of the quart of milk (which will have a content of 7 per cent. fat and 3.5 per cent. protein), in feeding certain selected infants who are not making satisfactory progress on the whole milk dilutions. When desirable, the 7 per cent. top-milk may be used in the mixture in amounts of 1½ ounces per pound, or 100 c.c. per kilogram, as an alternative for whole milk. Such mixtures will average about 3 gm. of fat per pound, or 6.6 gm. per kilogram of body weight.

While this amount of fat is in excess of the amount needed, only in exceptional cases will a healthy infant be upset by it.

High fat mixtures are contraindicated in most infants with disturbed digestion, except those in which it is due to carbohydrate intolerance or protein sensitization. In these instances the fat will often replace, in part at least, the insufficiency of carbohydrate and protein.

CREAM AND SKIMMED MILK MIXTURES

By the use of 16 per cent. cream and skimmed milk as the basis for various milk modifications, a wide range of combinations of the various food elements may be obtained. By the use of cream and skimmed milk, an additional factor is added for calculating the percentage content of the dilutions. *This is, however, not a great objection. The fact should be recognized that most physicians think of mixtures in terms of percentages without recognizing the possibility that one set of infants may receive large quantities of these dilutions in their day's feedings, while another group, under different care, may receive much smaller quantities and fewer feedings of the same quality of mixture.* If we accustom ourselves to think of the number of grams of fat, protein, carbohydrate and salts per kilogram or pound of body weight, it will in all probability offer the greatest possibilities of all the methods so far advocated.

For feeding purposes, gravity cream (of which about 6 ounces or somewhat less may be obtained from a quart of a good quality of milk) contains fat, 16; protein, 3.5, and carbohydrate, 4.5 per cent. The skimmed milk may be obtained by carefully pouring or dipping off the cream. It should contain fat, 0; protein, 3.5, and carbohydrate, 4.5 per cent.

The average infant should receive: fat, from 1.5 to 2 gm.; protein, 1.5 gm., and as a minimum of added carbohydrate, 3 gm. (above that contained in the cream and skimmed milk), per pound of body weight. These will be obtained by the use of cream (16 per cent.), skimmed milk and sugar, the contents of which are given in Table 23.

TABLE 23.—*Contents of Cream, Skimmed Milk and Sugar*

Cream (16 per cent. fat)	in 1 oz.	5 gm.	fat
Skimmed milk (3.5 per cent. protein)	in 1 oz.	1 gm.	protein
Sugar (100 per cent. carbohydrate)	in 1 oz.	30 gm.	carbohydrate

TABLE 24.—*Amounts Needed*

For each gram of fat	2/10 oz., or	6 c.c.	of cream
For each gram of protein	1 oz., or	30 c.c.	of skimmed milk
For each gram of carbohydrate	1/30 oz., or	1 gm.	of sugar

TABLE 25.—*Amounts for Each Pound of Body Weight*

Cream	3/10 to 4/10 oz. (fat, from 1.5 to 2 gm.)
Skimmed milk	1½ oz. (protein, 1.5 gm.)
Sugar	1/10 oz. (carbohydrate, 3 gm.)

TABLE 26.—*Amounts for Each Kilogram of Body Weight*

Cream	20-27 c.c. (fat, from 3.3 to 4.4 gm.)
Skimmed milk	100 c.c. (protein, 3.3 gm.)
Sugar	6.6 gm. (carbohydrates, 6.6 gm.)

The amounts needed are given in Table 24.

In the mixture, the ingredients will be used in the amounts, *per pound of body weight,* given in Table 25.

In the mixture, the ingredients will be combined in the amounts, *per kilogram of body weight,* given in Table 26.

In underweight infants, the amounts would be calculated on the basis of initial weight at the beginning

of feeding, but these would be increased gradually to the amounts necessary for a normal weight infant of the same age.

Example: It is desired to feed a 10-pound baby, fat, 20 gm.; protein, 15 gm., and carbohydrate, 30 gm., the amount required for one day's food. These quantities would be supplied by cream, 4 ounces; skimmed milk, 15 ounces; sugar, 1 ounce, and water, 11 ounces, bringing the total fluid to 3 ounces for each pound. The small excess of protein in the cream may be considered negligible.

It will be noted that by considering the needs of the infant in terms of weight and forgetting the percentage content of the variable mixture, the danger of error is removed and the variation due to the individual physician is done away with. At the same time this method of feeding becomes much simplified and retains all of its flexibility.

There can be no doubt as to the accuracy of the modifications that can be obtained by this method of feeding. It has the disadvantage of requiring more calculation. In actual experience, the disadvantage to healthy infants of a possible relative excess of protein in mixtures made with simple dilutions of whole milk has been exaggerated. Practical experience presents convincing evidence that far more infants develop gastro-intestinal disturbance from feeding excessively rich cream mixtures. The greatest objection to high milk feeding is the resultant high protein constipated stool, which can be obviated by adding more sugar.

CHAPTER XVIII

FEEDING DURING DIFFERENT PERIODS OF THE FIRST YEAR

The First Four Weeks of Life.—During the first two or three weeks of life, lesser relative quantities of food must be given than is recommended for later periods. During the first week, skimmed milk may be used in place of whole milk in amounts approximating 1 ounce to the pound of body weight. During the second week, the skimmed milk may be gradually replaced by whole milk, so that at some time during the third week the infant will be receiving one or more ounces of whole milk per pound of body weight. By the fourth week the infant can usually take the recommended 1½ ounces of milk per pound of body weight. Beginning with the addition of 0.5 gm. of cane or milk sugar for each pound of body weight, these can be increased to 1 gm. by the beginning of the second week, and to 2 or 3 gm. by the beginning of the third week. At all times an endeavor should be made to administer at least one sixth of the infant's body weight in water during the twenty-four hours.

Such mixtures must of necessity show a lower caloric value than will meet the infant's needs for growth and development, but, as suggested, the weak formulas should be used for mixtures for the new-born, and the strength increased according to the infant's tolerance. When there is positive evidence that the mother will have an insufficient milk supply, the milk mixtures should be increased in strength somewhat more rapidly during the first two weeks, or larger quantities fed than outlined in Table 27.

These mixtures should be boiled for three minutes over the direct flame, or a double boiler may be used.

In the latter case the water in the outer vessel should boil for eight minutes. Boiled water should be added to make up the original quantity.

Additional Foods from the Second to the Sixth Month.—The milk mixtures may be supplemented by the following additions to the diet:

Cereal waters may be used as the diluent beginning with the second month. These are best made from whole cereals, as the dextrinized flours are devitalized. From one-sixtieth to one-thirtieth ounce (from 0.5 to 1 gm.) of cereal for each pound of body weight may be used for making the amount of cereal water desired in the mixture.

TABLE 27.—*Diet for New-Born Infants During the First Four Weeks of Life*

	1st 48 Hrs.	3d to 4th Days	5th to 6th Days	7th, 8th and 9th Days	10th, 11th and 12th Days	13th and 14th Days	3d Wk.	4th Wk.
Milk (whole), ounces.....	..	..	..	3	4	6	8	11
Milk (skim), ounces.....	..	6	8	5	4	4	2	..
Sugar (cane), drams.....	1	1	2	2	2	3	4	6
Water (boiled), ounces....	16	10	8	8	8	8	8	10
Calories in mixture.....	15	81	118	148	158	215	250	321
Feedings:								
Amount in ounces.....	1	2	2.5	2.5	2.5	3	3	3.5
Number daily.....	6	6	6	6	6	6	6	6
Intervals in hours.....	4	4	4	4	4	4	4	4

Orange juice should be begun during the second month, beginning with one-quarter teaspoonful, diluted with water, twice daily, and increasing gradually until from one-half to 1 ounce is given by the end of the sixth month.

Cod liver oil, either phosphorized or plain, should be started by the third month, beginning with 5 drops daily, and increasing to 1 teaspoonful twice daily, by the end of the sixth month. From spoon or dropper.

Cereal gruels (oatmeal, farina, cream of wheat) can be started by the beginning of the fifth month. They should be well cooked. The gruel can be added to one of the midmorning meals and later to the evening meal as well, starting with one-half teaspoonful and increasing gradually until 2 or 3 tablespoonfuls is given twice daily.

BARLEY, OATMEAL AND RICE WATER

One-sixtieth to 1/30 ounce (0.5 to 1.0 gm.) of cereal, whole or flour, for each pound of body weight, should be used in preparation of cereal water additions to the mixture. This should then be boiled down to the amount required to bring the day's mixture up to the proper amount.

In using whole cereals and boiling for two hours in an open pan, use twice the amount of water needed for milk mixture to allow for evaporation. In 20 minutes' boiling of the flours about ⅓ is lost.

Flours—3 level tablespoonfuls = 1 ounce
Grains—5 level tablespoonfuls = 1 ounce

Soak the cereal grains in water overnight, pour off the water, add fresh water, and boil. Strain through fine cloth or sieve. Keep in icechest.

CEREAL (OATMEAL, FARINA, CREAM OF WHEAT)

2 tablespoonfuls cereal.
½ pint water.
½ pint milk.
1 pinch salt.

Cook in double boiler for one hour. Strain through a fine sieve.

Additional Foods from the Sixth Month to the End of the First Year.—A broth and vegetable meal may be gradually substituted for the midday meal. This is best given as a vegetable soup. Feeding should begin with 1 ounce, gradually increased to 8 ounces, 1 ounce of milk mixture being omitted for each ounce of soup given. If less than a full feeding is given, the meal should be finished with sufficient milk mixture, from a second bottle, to make a full feeding.

VEGETABLE SOUP (LAMB, CHICKEN, VEAL)

¼ pound of lean meat cut into small pieces.
1 potato, moderate size.
1 carrot.
2 stalks of celery.
1 tablespoonful of pearl barley.
2 tablespoonfuls of rice.
2 quarts of water.
1 pinch of salt.

Finely divide the vegetables. Add vegetables, barley and rice to the water. Boil down to 1 quart, cooking three hours. Add salt. Rub vegetables through a fine sieve. When in season, spinach, tomato, peas and beans may be added to the soup stock, if desired.

If kept in the upper compartment of the icechest against the ice, it may be used on the second day, but never later.

Strained vegetables (spinach, carrots, potatoes) may be added in small portions by the eleventh or twelfth months as a side dish. There is little advantage in so using them before this time, for the vegetables in the soup, when rubbed through a fine sieve, are incorporated in the broth.

Toast or dried bread crumbs may be added to the soup, if desired.

Stewed fruits (apples and prunes) may be fed in small quantities by the end of the first year. So far as their accessory food value is concerned, they are inferior to orange juice.

An infant should be taught to drink from a cup at least once daily in the latter part of its first year. This also holds true for the taking of its semisolids from a spoon.

Iron medication may be begun in the second half of the first year or earlier by administering some of the organic iron preparations or small doses of inorganic preparations, such as iron and ammonium citrate, one-half grain, twice daily.

EXAMPLES OF APPLICATION OF FEEDING RULES FOR WHOLE MILK DILUTIONS

Normal Infant, Aged Three Months.—This infant should weigh 11 pounds (average birth weight, 7 pounds, plus 4 pounds, representing a gain of 5 ounces weekly for thirteen weeks).

Estimating 1½ ounces of milk per pound of body weight, the result is 16½ ounces of milk.

Adding *3 gm. of cane sugar per pound of body weight,* or 1 ounce for each 10 pounds, the result is 1 1/10 ounces of sugar, or 2¼ level tablespoonfuls for 11 pounds.

TABLE 28.—*Amounts in Mixture for Normal Infant Aged Three Months*

	Protein	Fat	Carbohydrate	Salts Gm.	Calories
Milk (16.5 oz. = 495 c.c.)	17.3	19.8	19.8	3.46	346
Water (16.5 oz. = 495 c.c.)	....	....	....	....	...
Sugar (1.1 oz. = 33 gm.)	....	....	33.0	....	132
Total mixture (33.0 oz. = 990 c.c.)	17.3	19.8	52.8	3.46	478
For each pound of body weight	1.575	1.8	4.8	0.31	43

To make the total daily quantity 33 ounces (3 ounces of fluid per pound of body weight) it is necessary to add 16½ ounces of water to the quantity of milk used.

The baby should be fed five or six times daily, and should receive 5½ or 6½ ounces of the mixture at each meal.

For practical purposes cow's milk may be considered as averaging: fat, 4 per cent.; protein, 3.5 per cent.; carbohydrate, 4 per cent.

The amounts of the various elements in the mixture and the grams of each and calories per pound of body weight in the milk mixture as given above, for a normal 3-months old infant, weighing 11 pounds, are given in Table 28.

We thus find that the infant fed on the prescribed diet receives 33 ounces of the mixture containing: fat, 1.8 gm.; protein, 1.575 gm., and sugar, 4.8 gm. for each pound of body weight.

The infant receives 43 calories per pound of body weight.

Orange juice and cod liver oil should be included in the diet.

It should be remembered that the needs of the individual infant are to be covered, and some infants need food of a higher caloric value for each pound of body weight.

The mixture may readily be strengthened to meet indications for more fat and protein by the addition of milk or cream, and for more carbohydrates by the addition of flour and sugar. With the addition of more milk, the water should be decreased.

Infants inclined to vomit part of the feeding will often retain the food to better advantage by being fed small quantities (2½ ounces to the pound of body weight for the day) of a more concentrated mixture.

Normal Infant, Aged Eight Months.—The infant should weigh 17¼ pounds (average birth weight 7 pounds, which should be doubled in the first five months—14 pounds, plus a gain of 4 ounces a week for the remaining thirteen weeks—3¼ pounds).

The following mixture will be prepared:

One and one-half ounces of milk per pound of body weight, equals 26 ounces.

Water to make 1 quart, equals 6 ounces.

Sugar, 1½ ounces. As previously stated, the amount of sugar to be added is usually limited to 1½ ounces, further carbohydrate needs being furnished by the addition of cereal waters or cereals.

Starch, one-fourth ounce, or 8 gm. (approximately 1/60 ounce, or 0.5 gm. per pound).

This is to be fed in four feedings of 8 ounces each, and the fifth may be replaced by a soup and vegetable meal. A cereal feeding (from 2 to 4 tablespoonfuls) can also be given with one or two of the meals, part of the bottle of milk being poured over it, and the meal being finished with the remainder of the bottle.

Further needs of the individual child may be supplied by concentrating the milk until 1 quart of whole milk is given, the carbohydrates in the mixture being gradually decreased and given in another form, as gruel or custard.

Underweight Infant, Aged Three Months, Weight Eight Pounds.—For beginning, this mixture should be prepared: milk, 12 ounces (1½ ounces for each pound

TABLE 29.—*Amounts for Normal Infant Aged Eight Months*

	Protein	Fat	Carbohydrate	Salts Gm.	Calories
Milk (26.0 oz. = 780 c.c.)	27.3	31.2	31.2	5.46	546
Water (6.0 oz. = 180 c.c.)	....	....	....	....	...
Sugar (1.5 oz. = 45 gm.)	....	....	45.0	....	180
Starch (0.25 oz. = 8 gm.)	....	....	8.0	....	25
Vegetable soup (8.0 oz. = 240 c.c.)	2.0	4.5	8.0	2.4	144
Cereal (1 hpg. tblspoonful 1.0 = 30 gm.)	....	....	15.0	....	50
Total feeding	29.3	35.7	107.2	7.86	945
For each pound of body weight	1.7	2.1	6.2	0.46	55

of present weight); water 12 ounces; cane sugar, 8/10 ounce (1½ level tablespoonfuls, or 1/10 ounce or 3 gm. for each pound). This mixture is sufficient to make six feedings of 4 ounces each.

To meet the requirements of this infant for growth and development, the needs of a full-weight infant of the same age must be approximated as rapidly as the infant's tolerance for food permits. These increases can usually be made rapidly, if the infant is well other than for its underfeeding. The first increases are made in the carbohydrates by further addition of sugar and cereal water, until one-tenth ounce (3 gm.) per pound

of sugar and from one-sixtieth to one-thirtieth ounce (0.5 to 1 gm.) per pound of cereal flour, are added in the form of cereal water. These increases are calculated on the basis of average full weight (11 pounds for this age). The milk can be increased until from 1½ to 2 ounces per pound of full weight, or from 16.5 to 22 ounces for the total mixture is given. The total fluids should represent a minimum of 3 ounces per pound.

If the infant is suffering from digestive disturbances, it may be necessary to begin with 1 ounce of milk or even less per pound of its present weight, that is, 8 ounces or less in the mixture, adding only 1 or 2 gm. of sugar per pound. It must, however, be remembered that the infant will require 32 calories for each pound of body weight to sustain it; and if it is underfed for too long a period, inanition will result.

With equal simplicity, errors in the mixture received by infants seen in the daily routine of practice may be interpreted almost at a glance.

Example: An infant, aged 5 months, weight 12 pounds, on bottle feedings of milk, 15 ounces; water, 20 ounces; sugar, 2 ounces; feeding, 7 ounces, times, 5. Bowel movement three times daily.

An average infant at this age should have doubled its weight to 14 pounds and should therefore be receiving a minimum of 21 ounces of milk and 1 4/10 ounces of sugar. The error lies in the quantity of fat and protein, which is too small in proportion to the quantity of sugar. This, in most instances, would account for the increased number of stools and subsequent stationary weight.

CHAPTER XIX

FEEDING AFTER THE FIRST YEAR

The average infant fed on cow's milk mixtures will require as a minimum, per kilogram of body weight, during the later months of its first year, fat, 4 gm.; protein, 3.5 gm.; carbohydrates, 12 gm.; calcium oxid, 0.17 gm., and a total water content in its day's food including that contained in the milk equal to 125 c.c. per kilogram, which approximates one eighth of its body weight. (Per pound of body weight at 1 year: protein, 1.5 gm.; fat, 1.8 gm.; carbohydrates, 5.5 gm.; calcium oxid, 0.08 gm.; water, including that contained in the milk, equal to 2 ounces.)

TABLE 30.—*Amounts and Calories at One Year and at Six Years* *

	Grams or Cubic Centimeters per Kilogram				
	Protein, Gm.	Fat, Gm.	Carbohydrates, Gm.	Calcium Oxid, Gm.	Water, C.c.
At 1 year.....	3.5	4.0	12.0	0.17	125
At 6 years....	2.5	3.0	11.0	0.17	125
	Grams or Cubic Centimeters per Pound				
At 1 year.....	1.5	1.8	5.5	0.08	60
At 6 years....	1.2	1.35	5.0	0.08	60

* The percentage distribution of the calories in the diet will approximate: protein, 15.0; fat, 35.0; carbohydrates, 50.0.

Note.—1 gram of protein = 4.1 calories; 1 gram of fat = 9.3 calories; 1 gram of carbohydrates = 4.1 calories.

A diet so constructed will furnish approximately 100 calories per kilogram, or 45 calories per pound of body weight.

In a study of the diets of a large group of normal infants and children, Holt and his co-workers found that the food requirements of older infants and children showed a gradual decrease per kilogram of body weight after infancy. The *fat* taken diminished to 3 gm. per kilogram by the *sixth year*, while the *pro-*

tein intake decreased to about 2.5 gm. per kilogram at 6 years, and remained at this value or slightly below it until the end of growth. Of the protein, about 66 per cent. was in the form of animal protein from milk, eggs, meat, etc., the remainder being taken as vegetable protein. The *carbohydrates* should, to a large extent, be used to supplement the fat and the protein in the diet, the fat and protein, however, being first provided for. Holt believes on this basis that about 12 gm. of carbohydrates per kilogram at 1 year, with decreasing amounts to between 10 and 11 gm. per kilogram at 6 years, will properly balance the diets. The average of

TABLE 31.—*Average Amounts of the Various Food Constituents Required by Children*

Age in Years	Weight		Protein, Grams	Fat, Grams	Carbohydrate, Grams	Calories
	Pounds	Grams				
1	21.0	9,513	31.5	37.8	115.0	952
1½	25.3	11,460	38.0	45.5	140.0	1,153
2	28.0	12,684	39.2	47.6	154.0	1,235
3	32.9	14,905	42.5	52.6	164.0	1,336
4	36.1	16,353	46.93	54.15	180.0	1,434
5	41.2	18,663	49.4	57.7	206.0	1,584
6	45.0	20,385	54.0	60.75	225.0	1,709

all ages showed that about 50 per cent. of the carbohydrate was taken in in some form of sugar and an equal amount of starch. (Per pound of body weight at 6 years: protein, 1.2 gm.; fat, 1.35 gm.; carbohydrates, 5.0 gm.)

At 6 years the diets will approximate 85 calories per kilogram, or 38 calories per pound of body weight.

The essential mineral salts will be contained in sufficient amounts to meet the child's requirements in a well balanced diet. The total fluid requirements also decreased to an average of about one eighth of the body weight, 125 c.c. per kilogram, 60 c.c., or 2 ounces, per pound.

While the average healthy infant will require a greater amount of food per pound of body weight to

Fig. 10.—Diet for one day, infant aged 14 months.

7 A. M.	10 A. M.	2 P. M.	6 P. M.
Milk, 8 ounces	Milk, 8 ounces	Vegetable soup, 8 ounces	Milk, 8 ounces
Toast, 1 slice	Cereal, 3 tablespoons	Toast, 1 slice	Cereal, 3 tablespoons
Butter, ¼ cube	Sugar, one teaspoon	Butter, ¼ cube	Sugar, 1 teaspoon
Orange juice, 2 ounces	Bacon, 1 slice	Custard, 2 tablespoons	Stewed fruit, 1 tablespoon

meet its needs for growth and development, the average percentage distribution of the amounts and calories will remain approximately the same at the different ages.

ADDITIONS TO THE DIET AFTER THE FIRST YEAR

The diet of a growing child should be so constituted as to contain sufficient quantities of the following:

Whole Milk.—It has become our custom to postpone the feeding of whole milk without the addition of carbohydrates until after the first year. While there is no contraindication to feeding whole cow's milk by the beginning of the ninth month, or even earlier, when indicated, the milk being boiled or alkalized, the addition of carbohydrates above the amount contained in whole milk is of advantage to the infant, both from the standpoint of its metabolic needs and in lessening the tendency toward constipation in the artificially fed infant.

At no time is the infant to be fed more than 1 quart of whole cow's milk in twenty-four hours.

Unless the infant shows a tendency to take less than the required amount of milk in the form of a mixture, some water and 1 ounce of sugar are retained in the mixture until the infant is 1 year old. The water is gradually lessened from the tenth month so that by the end of the twelfth month only 2 to 4 ounces are retained— an amount sufficient to the sugar. The total fluid needs after the first year are a minimum of 2 ounces per pound of body weight daily. Water may be given from a bottle two or three times daily, although not essential if the diet contains sufficient to meet the infant's needs.

Cooked Cereals.—These should form a part of at least one or two meals. Those made from whole grain are the most valuable. The process of milling which

removes the outer shell of the grain causes a loss of the greater part of the protein, mineral matter and vitamins.

Toast and Bread Crusts.—Toast and bread crusts which have been spread with *butter* or *jelly* may be given at the end of one of the meals.

Green Vegetables.—These are especially valuable because of their mineral salts and vitamins. They also give a needed bulk to the food, thereby tending to prevent constipation. They may be classed in two large groups—the tubers, such as potatoes, turnips, beets and parsnips—and the green vegetables. Of the latter group the leafy vegetables, such as spinach, lettuce, cabbage, sprouts, chard, cauliflower, asparagus, celery, turnip and beet tops, have an especially high mineral and vitamin content, as well as being rich in iron. Peas and beans have a high protein content, but this is not sufficient to replace the animal proteins in the diet of the growing child. Tomatoes are especially valuable as an antiscorbutic. Whenever possible, the water in which the vegetables are cooked should be retained, as it contains a large part of the mineral salts of the plants.

Beef Juice.—Because of its high iron content, beef juice proves a valuable addition to the diet in the latter half of the first year. Beginning with one-half ounce, the quantity may be increased to 1 ounce or, at most, 2 ounces daily. It can be mixed to advantage with the vegetable purée.

Bacon.—A slice of crisp bacon containing very little lean may be given to advantage during the last months of the first year.

Broiled Lamb Chops; Scraped Beef; Chicken and Fish.—These may be added to the diet during the second year. All meats should be finely divided. Beef steak, roast beef and lamb are better withheld until the

child shows a tendency to masticate its food. Even young children may be allowed to gnaw meat from bones, because of the beneficial influence on the teeth, gums and salivary glands. The flesh foods confer a desirable palatability on vegetable foods with which they are served. They should form only a limited part of the diet of young children.

Fruits.—Fruit or fruit juices should always be considered a necessary addition to the daily diet, and should form a part of at least one meal. They can be used to best advantage at the end of the meal. Raw fruits are of even greater value than cooked fruits. Scraped apple and banana may be given early in the second year.

Honey and Jellies.—These may be spread on toast and bread.

Eggs.—These contain every factor vital to the needs of the body for development, but nevertheless need to be combined with other foods to balance the diet properly. They can be started at the beginning of the second year, either in the form of coddled egg or as egg custard. Very small amounts should be given at the first feeding until it is ascertained whether the infant has an idiosyncrasy to egg. After the fourteenth month, a half egg or more may be fed every second day. It may be alternated with beef juice or scraped beef.

Cottage and Cream Cheese.—These may form a part of the diet at the end of the second year.

Desserts.—Simple desserts, such as custard, pap, junket, gelatins, tapioca and rice pudding, are recommended during the second year. Only moderate quantities should be served, and then only at the end of the meal. The child should be taught to consume the major items of the meal before taking the dessert.

CHAPTER XX

FACTS TO BE CONSIDERED IN FORMULATING THE DIET

Children should be watched to see that they do not swallow their food without chewing it. It is stated that when we chew fibrous foods we exert a pressure of one hundred or more pounds on the teeth, and this insures a good circulation of blood in the inner part, and is an important factor in developing the teeth and jaws. It is especially important for children that the last article eaten should be of such a nature as to cleanse the teeth.

Soft foods require little or no mastication, and therefore call forth a minimum secretion of saliva and are of no aid in developing the jaws and preserving the teeth.

Green vegetables require mastication, and therefore have a beneficial effect in the development of the teeth; and, because of their bulk and some of their constituents, they stimulate intestinal peristalsis. Breadstuffs and meat have an added value in that they require mastication.

Carbohydrate residues tend to favor decay more than do meat and vegetable particles. It is therefore of great advantage to finish the meal with fruits, vegetables or hard crusts rather than with soft desserts and other sweets.

Eating Habits.—Young children should be fed at regular hours. Incessant eating is one of the greatest handicaps to proper development. The child should be taught what kind of a diet best promotes health, and encouraged to eat the food placed before it by the good example of the other members of the family. Eating between meals necessarily will result in a loss of appetite, and sooner or later the result becomes manifest in the child's lack of development. It often

becomes necessary to cultivate slowly a liking for spinach and other vegetables. It is always to be remembered that milk, cereals and vegetables must take precedence over meats and sweets. The diet should be so constructed in the individual case as to overcome any tendency toward constipation.

Overeating.—This is less likely to occur when the number of meals is limited to stated hours. The combination of overeating and constipation is probably the most important factor in the development of anorexia in childhood. It has been established that a reverse peristalsis may follow, with a flowing of the contents of the intestine back toward the stomach, with nausea and belching. This abnormal nervous reaction soon results in repugnance to all foods. Carbohydrate fermentation and protein decomposition in the intestinal tract aggravate the condition.

Poor Hygienic Conditions.—Lack of fresh air, too limited exercise and sleeping in closed rooms all have a detrimental influence on appetite, digestion and physical development.

PSYCHOLOGY OF CHILD FEEDING

Two factors are of prime importance—inheritance and environment. In order to meet the needs of the many children with whom the physician comes in contact, he must remember that individual children develop and grow at different rates, and that many, by reason of bad heredity, are neurotic and anemic; and when improper feeding is added to their difficulties, the resulting problem calls for tact in its solution.

The high tension, nervous child is frequently the offspring of neurotic parents. A nervous mother has a direct influence on the development of the infant. In such an environment, unless the child is an exceptional one, there is great liklihood of the daily routine being broken to meet the whims of the child. The introduc-

tion of new foods and changes in the methods of administering them often results in a rebellious attitude on the part of the child. These tendencies should be recognized in early infancy, and the importance of counteracting them impressed on the mother. The attitude that she is to assume toward the infant must be definitely explained, and, on her readiness to cooperate, the physician should base his opinion as to her fitness to have charge of her own child. If the child is placed in care of a nurse, the physician must painstakingly explain the requirements and handicaps of the individual case. It is self evident that a neurotic attendant does not improve the situation.

The modern tendency to provide an endless variety in foods for the growing child leads it to acquire false dietetic inclinations. The same may be stated about the more recent tendency to keep detailed notes on the calories consumed by the family. This habit in many instances is carried to the extreme, thus influencing the mother's better judgment. It should be the physician's duty to provide a suitable diet, and the mother's to serve it. To accomplish the desired result the child should be taught to enjoy proper exercise—rest periods should be maintained and good hygienic surroundings provided.

The appetite must not be considered a safe guide in the selection of food. The physician should consider it sound practice to prescribe what the child should eat, and the mother's duty to serve it.

A complete change of surroundings, such as moving from the city to the country, away from the influence of the parents, placing the child in charge of a proper attendant, commonly results in a speedy improvement in the general condition and stabilization of the nervous system.

Temporary hospitalization is sometimes necessary if the more ideal course cannot be realized.

Fig. 11.—Diet for one day, child aged 4 years.

7 A. M.

Cocoa, 8 ounces
Cereal, 6 tablespoons
Sugar, 1 teaspoon
Cream, 2 tablespoons
Egg (1 coddled)
Toast, 1 slice
Butter, ¼ cube
Apple sauce, 2 tablespoons

12 Noon

Milk, 6 ounces
Vegetables, 1 tablespoon potato
1 tablespoon spinach
Lamb chop, 1
Bread, 1 slice
Butter, ¼ cube
Rice pudding, 2 tablespoons
Lady fingers, 2

6 P. M.

Milk, 6 ounces
Cereal, 4 tablespoons
Sugar, 1 teaspoon
Cream, 2 tablespoons
Toast, 1 slice
Jelly, 1 tablespoon
Butter, ¼ cube
Prune pulp, 2 tablespoons

CHAPTER XXI

SUGGESTED AVERAGE DIETS FROM SIX MONTHS TO SIX YEARS, INCLUSIVE

The diets which are given in the following tables have been figured on a maximum basis. The general conditions surrounding the individual child must therefore be taken into consideration; otherwise, some of the amounts and varieties may be found excessive.

DIET FROM SIX TO NINE MONTHS

6 a. m. Breast or milk mixture, 8 ounces.
(Milk mixture: milk, from 22 to 28 ounces; sugar, 1½ ounces; water to make from 32 to 40 ounces as needed.)

8 a. m. Orange juice, 2 or 3 tablespoonfuls (sweetened).
Cod liver oil, one or two teaspoonfuls.

10 a. m. Breast or milk mixture, 8 ounces.
Cereal (farina, cream of wheat or oatmeal) 1 or 2 rounded tablespoonfuls.
The cereal may be added to the bottle, or some of the milk mixture may be added to the cereal—feeding by spoon.

2 p. m. Vegetable soup or milk mixture, total, 8 ounces.
When starting the soup feeding, first replace 1 ounce of milk with 1 ounce of soup and feed from a second bottle; gradually increase the soup and diminish the milk until the entire meal of soup is given.

6 p. m. Breast or milk mixture, 8 ounces.
Cereal (as at 10 a. m.).

10 p. m. Breast or milk mixture, 8 ounces.

DIET NINE TO TWELVE MONTHS

6 or 7 a. m. Milk mixture, 8 ounces. Milk, 6 ounces; water, 2 ounces; sugar, 2 level teaspoonfuls.

8:30 a. m. Orange or prune juice, 2 or 3 tablespoonfuls. If preferable, this may be given with the 10 a. m. or 2 p. m. meal.

10 a. m. Milk mixture, 8 ounces. Cereal (farina, oatmeal, etc.), from 2 to 4 tablespoonfuls.

2 p. m. Vegetable or cream soup, from 6 to 8 ounces, and
Zwieback or toast (crumbled), ½ slice, or
Milk, from 2 to 4 ounces.
Vegetables: strained spinach, carrot or squash (early), potato, peas, asparagus, celery (toward end of first year), 1 or 2 rounded tablespoonfuls, with
Beef juice, from ½ to 1 ounce.
Stewed fruit (prunes or apples), 1 tablespoonful.

6 p. m. Milk mixture, 8 ounces.
Cereal (farina, oatmeal, etc.), from 3 to 4 tablespoonfuls, with sugar, 1 teaspoonful.

DIET TWELVE TO FOURTEEN MONTHS

7 a. m. Milk, 8 ounces.
Cereals (farina, oatmeal, etc.), 3 or 4 tablespoonfuls with sugar, 1 teaspoonful; pour some of milk over cereal.
Bacon, 1 slice.
Orange juice, prune pulp or apple sauce, 1 or 2 ounces.

11 a. m. or 12 noon Vegetable or cream soup, from 6 to 8 ounces. and
Zwieback or toast (crumbled), 1 slice, plus one-fourth cube of butter, or
Milk, from 2 to 4 ounces.
Vegetables, 1 or 2 tablespoonfuls, with
Beef juice, from ½ to 1 ounce, or one-half of a coddled egg.
Dessert, corn-starch pudding or junket, 2 tablespoonfuls, or
Stewed fruit (prunes or apples), 1 or 2 tablespoonfuls.

3. p. m. Milk, 6 ounces.
Toast, zwieback or bread, one-half slice.
Butter, one-fourth cube.

6 p. m. Milk, 6 ounces.
Cereal (farina, oatmeal, etc.), 2 or 3 tablespoonfuls, with sugar, 1 teaspoonful.
Stewed fruits, 1 tablespoonful.

COMPUTATION OF DIET: AGE, FOURTEEN MONTHS; WEIGHT, TWENTY-THREE POUNDS

Food	Quantity	Protein, Gm.	Fat, Gm.	Carbohydrate, Gm.	Calories
Milk	20 oz.	20.0	24.0	30.0	420
Orange juice	2 oz.	0.6	0.1	8.0	40
Cereal (farina)	6 rd. tbsp.	3.0	0.6	21.0	102
Soup (vegetable)	6 oz.	6.75	0.3	8.25	64
Toast	2 slices	4.4	0.64	24.50	122
Butter	½ cube	0.08	6.50	0.6	60
Bacon	1 slice	0.4	1.8	0.0	18
Sugar	2 level teasp.	0.0	0.0	10.0	41
Pudding (custard)	2 rd. tbsp.	4.8	5.0	14.0	122
Total for 23 pounds		40.03	38.94	116.35	989
Per pound		1.74	1.69	5.0	43

DIET FOURTEEN TO EIGHTEEN MONTHS

7 or 8 a. m. Milk, 8 ounces.
One-half slice of toast, bread or roll, with one-fourth cube of butter.
Orange juice, 2 ounces, or prune pulp or apple sauce, 1 tablespoonful.
Cereals (farina, oatmeal, etc.), 3 or 4 tablespoonfuls with sugar, 1 level teaspoonful. Pour some of milk over cereal.
Bacon, 1 or 2 slices, or one half of 1 coddled egg.

12 noon Vegetable or cream soup, from 6 to 8 ounces, or milk, from 3 to 5 ounces.
Zwieback or toast (crumbled), 1 slice, with butter, ¼ cube.
Vegetables: One or two tablespoonfuls each of two fresh vegetables.
Beef juice, 1 ounce, or
Scraped beef, 1 tablespoonful, or
1 small lamb chop (lean portion), or
Minced chicken, 1 tablespoonful.
Dessert: Corn-starch pudding, or junket, 2 tablespoonfuls,
or
Stewed fruit (prunes or apples) 2 tablespoonfuls.

3 p. m. if desired.
Milk, 6 or 8 ounces.
Toast, zwieback, small slice, or one cookie.

6 p. m. Milk, 8 ounces.
Cereal, 3 tablespoonfuls: farina, cream of wheat, oatmeal, etc., with sugar, 1 level teaspoonful.
Bread or toast, one-half slice, with one-fourth cube of butter.
Stewed fruit, 1 tablespoonful.

DIET EIGHTEEN TO TWENTY-FOUR MONTHS

7 or 8 a. m. Milk, 8 ounces.
1 slice toast, bread or roll, with one-fourth cube of butter.
Cereals (farina, oatmeal, etc.), 3 or 4 tablespoonfuls, with sugar, 1 level teaspoonful; some of milk over cereal, and 1 tablespoonful cream.
Bacon, 2 slices, or 1 coddled egg.
Orange juice, 2 ounces; prune pulp, baked apple, apple sauce or scraped pineapple, etc., 1 tablespoonful.

12 noon Vegetable or cream soup, 6 ounces, or milk, from 4 to 6 ounces.
Zwieback or toast (crumbled), 1 slice, with one-fourth cube of butter.
Vegetables: One or two tablespoonfuls each of two fresh vegetables.
Beef juice, 1½ ounces, or
Scraped beef, 2 tablespoonfuls, or
1 small lamb chop, or
Minced chicken, 2 tablespoonfuls.
Dessert: Corn-starch pudding, or junket, 4 tablespoonfuls,
or
Stewed fruits, 2 tablespoonfuls.

3 p. m. if desired.
Milk, 6 or 8 ounces.
1 slice of toast, bread or roll with one-fourth cube of butter or 2 or 3 cookies.

6 p. m. Milk, 6 ounces.
Cereals, 3 or 4 tablespoonfuls: farina, cream of wheat, oatmeal, etc.
Bread or toast, with honey or jelly, one-half tablespoonful, with one-fourth cube of butter.

DIET TWO TO FOUR YEARS

7 or 8 a. m. Milk or cocoa, 8 ounces.
Cereals (cooked preferable), from 4 to 6 tablespoonfuls, with sugar, 1 level teaspoonful, some of milk over cereal, and 1 or 2 tablespoonfuls of cream.
Bacon, 2 slices,
or
Egg, 1 coddled, poached or scrambled.
Bread or toast, 1 slice.
Butter, ¼ cube.

Fruit: Orange juice, grapefruit juice, prune pulp, baked apple, apple sauce, or scraped pineapple, etc., 2 tablespoonfuls.

12 noon Milk or vegetable soup, 6 ounces.
Vegetables: One tablespoonful each of two fresh vegetables.
Beef juice, 1½ ounces,
or
Lamb chop (1), fish, chicken, scraped steak (⅓ pat) sweetbreads, etc.
Bread or toast, 1 slice.
Butter, ¼ cube.
Dessert: Corn-starch pudding, custard, tapioca, rice, junket, etc., 2 tablespoonfuls,
or
Stewed fruits, from 2 to 4 tablespoonfuls,
or
Fresh fruits: ½ apple, 1 peach, plum or pear, ½ grapefruit or banana.
Tea biscuit, lady fingers, etc., 1 or 2.

6 p. m. Milk, 6 ounces.
Cereal (3 or 4 tablespoonfuls): farina, cream of wheat, oatmeal, etc.; sugar, 1 level teaspoonful; some of milk over cereal, and 1 or 2 tablespoonfuls of cream.
Bread or toast, 1 slice, with honey, syrup or jelly, 1 tablespoonful.
Butter, ¼ cube.
Stewed fruit, 1 or 2 tablespoonfuls.

COMPUTATION OF DIET; AGE, FOUR YEARS; WEIGHT, THIRTY-SIX POUNDS

Food	Quantity	Protein, Gm.	Fat, Gm.	Carbohydrates, Gm.	Calories
Milk	14 oz.	14.0	16.8	21.0	294
Orange juice	2 oz.	0.6	0.1	8.0	40
Cereal (farina)	10 rd. tbsp.	5.0	1.0	35.0	170
Egg	One	6.6	6.0	0.0	80
Toast	3 slices	6.6	0.96	36.0	183
Butter	¾ cube	0.12	9.75	0.9	90
Vegetables—Potato	1 rd. tbsp.	0.8	0.03	17.0	32
Spinach	1 rd. tbsp.	1.1	0.2	1.4	12
Lamb chop	One	6.5	9.0	0.0	107
Rice pudding	2 rd. tbsp.	4.2	3.4	17.2	120
Stewed fruit	4 rd. tbsp.	0.48	0.8	36.0	152
Sugar	1 level teasp.	0.0	0.0	5.0	20
Lady fingers	Two	1.0	0.6	8.5	43
Total for 36 pounds		47.00	48.64	176.0	1,343
Per pound		1.3	1.35	5.0	37.3

DIET FOUR TO SIX YEARS

7 or 8 a. m.
- Milk or cocoa, 8 ounces.
- Cereals (cooked preferable), from 4 to 6 tablespoonfuls, with sugar, 1 teaspoonful, and cream, 2 tablespoonfuls.
- Bacon, 2 or 3 slices,
  or
- Egg, 1 coddled, poached or scrambled.
- Bread or toast, 1 slice.
- Butter, ¼ to ⅓ cube.
- Fruit: Orange juice, grapefruit juice, 2 ounces, prune pulp, baked apple, apple sauce, or scraped pineapple, etc., 2 to 3 tablespoonfuls.

12 noon
- Milk or vegetable soup, 6 ounces.
- Vegetables: Two tablespoonfuls each of 2 fresh vegetables.
- Meat: Lamb chop, 1; scraped steak, ½ pat; fish, chicken, lamb, or beef, 1 slice.
- Butter, ¼ to ⅓ cube.
- Dessert: Corn-starch pudding, custard, tapioca, rice junket, gelatin or other simple dessert, from 2 to 4 tablespoonfuls.
- Fresh fruit: One-half apple, 1 peach, plum or pear, ½ grapefruit or banana.
- Tea biscuit, lady fingers, 1 or 2, or light cake, 1 slice.

6 p. m.
- Milk, from 6 to 8 ounces.
- Cereals, from 4 to 6 tablespoonfuls, with sugar, 1 level teaspoonful, and cream, 2 tablespoonfuls.
- Bread or toast, 1 slice.
- Butter, ¼ to ⅓ cube; jelly, syrup or honey, 1 tablespoonful.
- Stewed fruit, 2 or 3 tablespoonfuls.

Note.—Salads: Fruit, lettuce, tomato, etc., may be added to the diet at this age.

Cheese: Cottage and cream cheese may be given in moderate quantities.

FOOD VALUE OF INDIVIDUAL SERVINGS *

Foods	Approximate Quantity	Weight, Gm.	Protein, Gm.	Fat, Gm.	Carbohydrates, Gm.	Calories in Portion	Cal. per 100 Gm.
MEATS (Cooked)							
Beef juice	1 oz.	30	1.5	0.18	0.0	8	26.5
Beef roast	4×4×½″	100	22.0	28.0	0.0	350	350
Beefsteak, round	4×4×½″	100	28.0	8.0	0.0	185	185
Beef tenderloin	2½×2½×1″	100	23.5	20.4	0.0	286	286
Beef, scraped	4 in. pat	100	21.0	10.6	0.0	185	185
Veal roast	Thin slice 4×4″	36	9.9	0.43	0.0	44	122
Lamb chops	Flesh of one	30	6.5	9.0	0.0	107	360
Lamb roast	3½×3½×¼″	37	7.3	4.7	0.0	71	192
Mutton, roast leg	3½×3½×¼″	37	9.2	8.3	0.0	112	300
Ham, boiled	Thin slice 4×3″	30	6.0	6.7	0.0	85	283
Bacon, fried	Thin slice	4	0.4	1.8	0.0	18	450
Chicken, roast	Thin slice 3½×4″	35	10.7	1.5	0.0	56	160
Meat, stewed with vegetables	1 cup, 8 oz.	240	11.0	12.0	26.0	260	108
FISH (Cooked)							
Bluefish	Thin slice 3×3″	75	19.4	3.4	0.0	108	144
Cod	Thin slice 3×3″	75	16.5	0.15	0.75	70	93
Oysters, uncooked	6 oysters	80	4.8	1.0	2.6	39	50
SOUPS							
Homemade:							
Beef	4 oz.	120	5.3	0.5	1.3	32	26
Bean	4 oz.	120	3.8	1.7	11.0	78	65
Chicken	4 oz.	120	12.6	1.0	3.0	72	61
Cream vegetable	4 oz.	120	4.5	0.2	5.5	43	36
Canned:							
Asparagus, cream of	4 oz.	120	3.0	4.0	6.6	76	63
Chicken	4 oz.	120	4.2	0.12	1.8	24	20
Oxtail	4 oz.	120	4.8	1.56	5.16	55	46
Pea	4 oz.	120	4.32	0.84	9.12	63	52
Tomato	4 oz.	120	2.16	1.32	6.72	49	41
Vegetable	4 oz.	120	3.48	0.0	0.6	17	14
EGGS							
Whole egg, boiled	One egg	50	6.6	6.0	0.0	82	164
Yolk, boiled	Yolk of one	18	2.9	6.0	0.0	66	370
Yolk, raw							
White, boiled	One egg	32	4.16	0.06	0.0	16	55
White, raw							
Omelette	3 eggs, 3 tbsp. milk, 1 teasp. butter	150	20.0	28.0	3.0	350	240
DAIRY PRODUCTS							
Milk	1 oz.	30	1.0	1.2	1.5	21	70
Cream	1 oz.	30	0.75	5.5	1.35	58	190
Buttermilk	1 oz.	30	0.75	1.5	1.5	10	33
Butter	1-in. cube	15	0.15	13.0	1.15	120	800
Cheese, American	1-in. cube	20	5.7	7.0	0.06	90	450
Cheese, Camembert	1 full teasp.	20	4.2	4.3	0.0	58	290
Cheese, cottage	1-in. cube	20	4.0	0.2	1.0	25	125

* In computing these tables, free use has been made of U. S. Dept. of Agriculture Bulletin 28 (Atwater and Bryant), Farmers's Bulletin 142 (Atwater), E. A. Locke, On Food Values, D. Appleton & Co., New York, and Amye Pope, A Dietary Computer, G. P. Putnam's Sons, New York.

FOOD VALUE OF INDIVIDUAL SERVINGS—Continued

Foods	Approximate Quantity	Weight, Gm.	Protein, Gm.	Fat, Gm.	Carbohydrates, Gm.	Calories in Portion	Cal. per 100 Gm.
CEREALS							
Farina (boiled)	1 rd. tbsp.	30	0.5	0.1	3.5	17	57
Cream of wheat (boiled)	1 rd. tbsp.	30	0.5	0.12	3.5	17	57
Hominy (boiled)	1 rd. tbsp.	30	0.7	0.06	5.4	25	82
Oatmeal (boiled)	1 rd. tbsp.	30	0.8	0.35	3.3	20	60
Corn flakes	1 rd. tbsp.	3	0.3	0.04	2.3	11	365
Rice (boiled)	1 rd. tbsp.	30	0.8	0.03	7.5	34	110
Macaroni (boiled)	1 rd tbsp.	30	1.0	0.5	5.2	30	100
Shredded wh. biscuit	One	30	3.0	0.4	23.0	109	365
BREADS							
White	Slice 3½×3×½″	30	2.76	0.39	15.9	80	268
Wheat, whole	Slice 3½×3½×½″	42	4.0	0.38	21.0	106	251
Corn	Slice 3×2×¾″	39	3.0	1.8	18.0	100	260
Toast	Slice 3×3×½″	20	2.2	0.32	12.24	61	305
Cream toast	Slice	70	9.0	7.3	18.5	160	230
Zwieback	2 slices, small	15	1.5	1.5	11.0	65	434
Rolls, French	One roll	39	3.3	1.0	21.7	112	287
Rolls, Vienna	One roll	45	3.8	1.0	25.0	128	284
CRACKERS							
Soda	One	6	0.59	0.55	4.38	25	424
Saltines	One	3	0.32	0.38	2.0	13	492
Graham	One	8	0.8	0.75	5.9	34	429
Oatmeal	One	10	1.18	1.11	6.9	43	434
Cookies	One						
SANDWICHES							
Chicken	One	70	8.6	3.8	22.5	165	235
Egg	One	100	9.6	12.7	34.5	300	300
Ham	One	70	7.2	10.0	26.6	233	332
VEGETABLES							
Cooked:							
Beans (baked)	1 rd. tbsp.	33	2.45	3.0	7.4	68	204
Beans, lima	1 rd. tbsp.	20	1.6	0.14	6.0	32	160
Beans, string	1 rd. tbsp.	30	0.25	0.33	0.75	7	23
Beets	1 rd. tbsp.	35	0.8	0.03	2.6	14	40
Cabbage	1 rd. tbsp.	30	0.5	0.09	1.8	10	33
Carrots	1 rd. tbsp.	33	0.2	0.05	1.17	6	18
Cauliflower	1 rd. tbsp.	20	0.35	0.09	0.95	6	30
Turnips	1 rd. tbsp.	30	0.4	0.05	2.5	12	40
Spinach	1 rd. tbsp.	30	1.1	0.2	1.45	12	40
Corn (cut off ear)	1 rd. tbsp.	30	0.8	0.36	5.8	30	100
Onions	1 rd. tbsp.	30	0.4	0.06	1.7	9	30
Peas	1 rd. tbsp.	30	2.1	0.1	4.6	28	92
Asparagus tips	1 rd. tbsp.	30	0.6	0.05	1.0	7	23
Potato, white	1 rd. tbsp.	30	0.8	0.03	7.0	32	105
Potato, sweet	1 rd. tbsp.	30	0.6	0.2	8.4	38	125
Potato (baked)	1 med. size	80	2.1	0.06	17.5	79	100
Uncooked:							
Celery	2 stalks	20	0.22	0.02	0.66	4	20
Cucumbers	6 thin slices	30	0.24	0.06	0.93	5	17
Lettuce	Small heart 3″ diameter	50	0.60	0.15	1.45	11	22
Radishes	4 med. size	35	0.45	0.03	2.03	10	30
Tomatoes	1 med. size	100	0.90	0.40	3.90	23	23

FOOD VALUE OF INDIVIDUAL SERVINGS—Continued

Foods	Approximate Quantity	Weight, Gm.	Protein, Gm.	Fat, Gm.	Carbohydrates, Gm.	Calories in Portion	Cal. per 100 Gm.
VEGETABLES							
Canned:							
Asparagus	8 tips 3 in. long	93	1.67	0.18	3.06	20	22
Beans, baked navy	1 heaping tbsp.	40	2.7	1.0	7.5	50	125
Corn	1 heaping tbsp.	50	1.4	0.6	9.5	50	100
Tomato	1 heaping tbsp.	35	0.42	0.07	1.4	8	23
FRUITS							
Uncooked							
Apples	1 med. size	125	0.5	0.6	18.0	80	64
Bananas	1 med. size	110	1.43	0.66	24.0	108	100
Cantaloupe	½ melon	465	1.4	0.0	21.4	93	20
Grapefruit	½ large	300	2.4	0.6	30.0	140	47
Oranges	1 medium 5 oz. juice	250	1.5	0.25	21.0	96	37
Peaches	1 medium	80	0.56	0.08	7.5	33	40
Pears	1 medium	150	0.9	0.75	16.0	95	64
Plums	1 medium	35	0.32	0.0	5.69	29	81
Strawberries	4 hpg. tbsp.	100	1.0	0.60	7.4	40	40
Watermelon	Large slice	300	0.6	0.3	8.0	39	13
Canned:							
Apricots	2 halves plus tbs. sirup	80	0.72	0.0	13.8	58	72
Peaches	1 half plus 1 tbs. sirup	80	0.56	0.08	8.6	37	46
Pears	1 small plus 3 tbs. sirup	110	0.33	0.33	19.8	83	75
Cooked:							
Apple (baked)	1 large (4 oz.)	120	0.6	0.6	30.0	128	100
Apple sauce	1 rd. tbsp.	30	0.12	0.2	9.0	38	125
Prune pulp	1 rd. tbsp.	30	0.45	0.0	9.5	40	132
Marmalade, orange	1 rd. tbsp.	30	0.2	0.03	26.0	105	345
Jelly, currant	1 rd. tbsp.	30	0.38	0.0	27.0	113	370
Dried:							
Apricots	5 large	41	1.9	0.4	25.0	114	284
Dates	5 large	40	0.8	1.0	30.0	133	320
Figs	5 large	100	4.2	0.3	72.0	315	315
Prunes	5 large	100	1.8	0.0	62.0	260	260
Raisins	Ten	25	0.57	0.75	17.0	80	320
SUGAR							
Granulated	1 level dessert spoon	10	0.0	0.0	10.0	41	410
Cubes	One	7	0.0	0.0	7.0	29	410
Dominoes	One	6	0.0	0.0	6.0	25	410
Milk sugar	1 level tbsp.	10	0.0	0.0	10.0	41	410
Honey	1 tbsp.	30	0.12	0.0	24.3	101	335
Maple syrup	1 tbsp.	30	0.0	0.0	21.4	88	293
Karo syrup	1 tbsp. (20 c.c.)	30	0.0	0.0	23.0	95	318
Fudge	1×1×¾″	28	0.8	2.2	11.0	70	250
Lolly pop	1¾×⅜″	27	0.0	0.0	25.0	102	380
Milk chocolate	1×2×¼″	10	0.75	3.0	6.5	58	580

FOOD VALUE OF INDIVIDUAL SERVINGS—Continued

Foods	Approximate Quantity	Weight, Gm.	Protein, Gm.	Fat, Gm.	Carbohydrates, Gm.	Calories in Portion	Cal. per 100 Gm.
ICES							
Ice cream	1 hpg. tbsp.	50	2.6	5.0	9.0	95	190
CAKE							
Chocolate layer	3½×¾×1¾″	40	2.48	3.24	25.6	140	350
Ginger bread	2×3×1″	60	3.5	5.4	38.0	220	365
Lady fingers	One	12	1.0	0.6	8.5	43	350
Sponge	2×3½×½″	23	1.45	2.5	15.0	91	396
PIES							
Apple	One sixth	126	3.9	12.35	54.0	352	280
Custard	One sixth	133	5.6	8.4	34.7	243	183
Lemon cream	One sixth	110	4.0	11.1	41.0	288	262
Squash	One sixth	133	5.8	11.1	28.8	246	185
NUTS							
Almonds	Ten large	15	3.1	8.2	2.6	100	668
Peanuts	15 (in shell)	30	5.8	8.7	5.5	128	427
Walnuts, English	Ten	42	7.7	27.0	5.5	306	728
PUDDINGS							
Bread pudding Ingredients: 1 cup bread crumbs 1 cup milk 1 egg ½ cup sugar ¼ cup raisins	1 rounded tbsp.	35	1.8	1.6	13.0	75	220
Baked custard Ingredients: 2 cups milk 2 eggs ¼ cup sugar	1 rounded tbsp.	45	2.4	2.5	7.0	61	135
Soft custard Ingredients: Yolk 1 egg ½ cup milk 1 h. tbsp. sugar	1 rounded tbsp.	10	1.7	1.1	2.0	22	220
Rice custard Ingredients: 1 cup boiled rice 2 eggs 1½ cups milk 2 h. tbsp. sugar	1 rounded tbsp.	35	2.15	1.7	8.6	60	170
Floating island Ingredients: ½ tsp. cornstarch 1 h. tsp. sugar 1 egg 1 cup milk.	1 rounded tbsp.	18	1.65	1.7	3.0	35	200

Comparative approximate measurements: 1 rounded tablespoonful equals 1 ounce by volume, cooked vegetables, cereals and meat cut in small pieces; 1 heaping tablespoonful equals 1½ ounces by volume, cereals; 2 level tablespoonsful equal 1 ounce by volume, cane sugar.